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Notes on Maize.

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I.

The words *Zea Mays* are only fitted for generic use. So numerous and divergent in appearance and use are the varieties of corn already known that to call all by one name is to speak too indefinitely for any practical purpose. *Zea Mays* may mean the dwarf pop growing but eighteen inches tall in our gardens, or the huge something which is reported as over twenty-four feet tall in Central America—a variety so hard that the national custom is to parch before attempting to pulverize, or so soft as to readily reduce to meal on a hollow stone—a variety which, despite extensive distribution, cannot compete with a commercial form, or a form which enters into commerce—a variety whose hundred kernels weigh but 46 grains, or another whose hundred kernels weigh 1531 grains. If we consult botanies we find nothing of any help towards determining questions of climatic relation, of adaptability or environmental reaction. If we examine pages of travel, of archeology, of ethnology or of history, we fare scarcely better in securing sufficient preciseness of mention for purposes of study. From whatever point of view we attempt an examination into the natural and economic history of the maize plant and product, we meet with difficulties, usually insurmountable, arising from indefinitiveness of nomenclature.

It seems the universal experience that scientific investigation cannot be well accomplished without a distinct and sufficient nomenclature. The lack of precise names for cultivated plants has served to discourage study, and to discredit much of the work which has been inefficiently attempted. Systematic botanists at present seem to endeavor to mass divergent forms into a common species. As valuable as this attempt may be for wild plants, yet when applied to cultivated plants the tendency is to form groups too unwieldy for the purpose of those who would study into causes and effects of changed environments. For the successful study of plants of economic relation and great variability there is need of a precise system of nomenclature, and the only at present requisite is the absolute and ready delimitation of groups under a name system approved by botanists, and which shall not become perverted by popular use, as is the likelihood with vernacular names. In the present jejune condition of agricultural botany we may properly leave for future discussion those questions relating to genealogy, and be satisfied with a system that is accurate and convenient, and which shall enable us to record observations and results of study in a form available for use. I have hence sought for an improved nomenclature for maize, and the longer acquaintance I have had with my groups the more justified I am in my belief that in convenience and availability they leave but little to be desired.

From a botanical standpoint, I am disposed to accept *Zea tunicata* as a primitive form, from which are derived: *Zea everta*, the pop corns; *Zea indurata*, the flint corns; *Zea indentata*, the dent corns; *Zea amylacea*, the soft corns; *Zea saccharata*, the sweet corns; and *Zea amyleasaccharata*, the starchy-sweet corns.

Each one of five of these species furnishes three well-defined sub-species, with parallel relationship throughout. Thus, sub-species A, the kernel broader than deep; sub-species B, the kernel as broad as deep; sub-species C, the kernel much deeper than broad. All my collections concur towards the belief that climatic relations are more evident in these sub-species than in the species themselves. With the possible exception of the dent corns and the starchy-sweet, for which but one locality is as yet known, the climatic range and adaptability seem about the same, but in the

sub-species there is diversity, A being for climates of short season, C for long seasons, while B in general is intermediate, although a climate suitable for C can grow A and B. Sub-species A is the only kind represented in our more Northern collections of *Z. indurata* from Lake of the Woods, Northeastern Canada and North Dakota; of *Z. amylacea* from Manitoba; of *Z. indentata* from North Dakota; of *Z. saccharata* from Northern Maine and Northern Minnesota. Sub-species B comes from a little south of the before-mentioned range, and extending south especially throughout the elevated regions. Sub-species C is yet more southern, and rarely comes to me from regions of short season.

The number of varieties of Indian growing, or of Indian origin, which I have seen or collected, appear in the annexed table:

	Zea everta.	*Zea indurata.*	*Zea indentata.*	*Zea amylacea.*	*Zea saccharata.*	*Zea amylasaccharata.*
Arizona cliff-dwellers (Nat. Mus.), Seen.				1		
Arizona Indian (From Dr. Vasey)				5		
Brazil Indian, San Paulo (From Prof. Derby)				2		
Cocopa Indian, Mexico (From Dr. Palmer)				3		
Dacota Indian, Fort Lincoln		1				
Guadalajara Indian, Mexico (From Dr. Palmer)				1		
Illinois Indian, Wyandotte				1		
Michigan Indian, Squaw				1		
New England Indian		4				
North Carolina Indian. Tuscarora in three colors				3		
Omaha Indian, Nebraska Black				1		
Peruvian. Mummy Cuzco				2		
San Padro Indian, Mexico (From Dr. Palmer)		1	7	4		3
Sioux Indian, Golden Sioux		1				
Susquehanna Indian. Eight-rowed sweet					1	
Tarahumarer Indian, Mexico (From Dr. Palmer)		2	1	5		
Tesuque, Pueblo, 1892, Seen.				6		
Yacqui Indian, Mexico (From Dr. Palmer)		1				
Zuni Indian, New Mexico (From Mr. Cushing)				6		
Totals	0	10	8	41	1	3

Dr. Edward Palmer, in a letter accompanying the Cocopa Indian corn, wrote that the same varieties were cultivated by the Mohave, Pima and Yuma Indians of the United States.

From my reading I think it is reasonably safe, although somewhat conjectural, to identify references to our species, as follows:

	Zea everta.	*Zea indurata.*	*Zea indentata.*	*Zea amylacea.*	*Zea saccharata.*
Canada Indian,		2			
Cliff-dwellers,	1		1	2	
Guaranies, of Paraguay,	2	1		1	
Honduras Indian,		1			
Mandan Indian,	1	1			
Mexican Indian,					1
New England Indian,		3			
Peruvian Indian,	2	4	1	6	1
Pueblo Indian,				3	
Virginian Indian,		1	1		
West Indian. Hispaniola,				1	
Totals,	6	13	3	13	2

The species described or mentioned by me in the Report of the New York Agricultural Experimental Station, 1884, with figures and diagrams of 126 varieties, are thus represented in tabular form:

	Sub-species A.	Sub-species B.	Sub-species C.	Totals.
Zea everta, Pop corns,	4	5	19	28
Zea indurata, Flint corns,	27	9	8	44
Zea indentata, Dent corns,	8	2	38	48
Zea amylacea, Soft corns,	7	5	2	14
Zea saccharata, Sweet corns,	14	12	8	34
Totals,	60	33	75	168

I have since received from Chili, one variety soft corn, subspecies B., and four varieties soft corn, sub-species C.

The regermination of cornseed, after drying, has a bearing on the question of the distribution of the seed in nature. Some

trials in 1883 showed that sprouted seed air-dried for seven days, and then replanted, would renew growth. The per cent. germinating at the successive trials were as follows:

	Germination per cent., same seed, each trial.					Total days air-dried.	
	I.	II.	III.	IV.	V.	VI.	
Flint varieties, . .	99	96	63	30	22	0	33
Dent " . .	80	78	14	21	0	0	24
Rice pop, ...	100	96	29	43	44	0	28

The comparative hardiness and prolificacy of our species, as determined under similar conditions of spacing and planting, is seen below.

	Varieties or Selections Tested.	No. of Seed Planted.	No. of Mature Plants Furnished.	No of Good Ears in Crop.
Zea everta, ...	15	712	625 or 88 per cent.	670 or 1.07 per plant.
Zea indurata, ...	11	504	373 or 74 " "	290 or 0.77 " "
Zea indenta, ...	20	1312	606 or 46 " "	409 or 0.67 " "
Zea amylacea (Tuscarora),	6	263	86 or 32 " "	134 or 1.55 " "
Zea saccharata, ...	27	1176	726 or 62 " "	756 or 1.04 " "
Zea tunicata (Dent form),	9	400	166 or 41 " "	105 or 0.63 " "

These results for prolificacy are not, however, strictly comparable, as prolificacy is determined largely by the spacing of the plants. Thus in a trial with Waushakum flint corn.

1 plant, per hill, the yield per plant, 3.5 good ears and 1.1 poor ears.
2 " " " " " " " 2.1 " " " 0.8 " "
3 " " " " " " " 1.5 " " " 0.4 " "
4 " " " " " " " 1.2 " " " 0.2 " "
5 " " " " " " " 1.0 " " " 0.2 " "

Most sorts of corn will germinate when quite unripe, in the milk or before hardening of the kernels has taken place. The more flinty the corn the earlier and more certainly does the germination occur. The order in my trials has been flint, sweet, dent.

As to distribution by countries my information is very incomplete. The varieties that are represented in my collections are as follows:

	Pop.	Flint.	Dent.	Soft.	Sweet.	Starchy-sweet.	Totals.
From Africa,	—	7	1	—	—	—	8
" Brazil,	2	3	1	2	—	—	8
" Chili,	—	—	—	6	—	—	6
" France,	4	5	2	2	1	—	14
" Peru,	—	—	—	2	—	—	2
" Mexican Indian,	—	4	8	13	—	3	28
" Venezuela,	—	—	2	—	—	—	—
" U. S. Indian,	—	6	—	17	1	—	24
" U. S. Cultivation, 1884, 1885,	13	46	45	4	43	—	151
Totals,	19	71	59	46	45	3	243

The hour at which first germination was noted at various temperatures, for each species, is given in the following table, the temperatures being the extremes during the trials:

	41°–43.7° F.	45.3°–50.7° F.	48.5°–58.5° F.
Zea everta.—Dwarf Golden,	498	228	141
White Pearl,	378	228	141
Amber Rice,	378	228	141
Zea indurata.—Waushakum,	331	228	142
Eight-rowed White,	331	216	150
Zea indentata.—Adam's Early,	233	180	142
Chester Co. Mammoth,	233	168	142
Zea amylacea.—Tuscarora,	378	228	161
Zuni Blue,	431	228	185
Zea saccharata.—Stowell's Evergreen,	452	288	195
Narragansett,	498	300	209

II.

Zea everta, the Pop Corns. N. Y. Ex. Sta. 1884, 183; 1882, 59, *fig.*

The kernel split laterally shows the chit and corneous matter enveloping. In some cases a fine starchy line. The small size of the kernel and the property of "popping" makes identification certain.

Zea curagua Molin. Bonafous, Mais, 1836, 29. (A pearl pop.)

Zea Mays Lam. Ill. 1823, *t. 749, fig. f.* (A twelve-rowed pop.)

Zea hirta Bonaf. l. c. *t. 4.* (A pearl pop).

Zea rostrata Bonaf. l. c. 32. (A rice pop.)

Zea Mays præcox Bonaf. l. c. (A golden pop.)

Zea Mays minima Bonaf. l. c. (A dwarf-golden pop).

Zea canina Wats. Proc. Am. Acad. **26**: 161. (A rice pop.)

The common eight-rowed pop seems to have no history, although probably in cultivation in New England from early times. It belongs to sub-species A. The plants frequently bear several ears to a stalk and are subject to monstrous growth. The twelve-rowed, a representative of sub-species B, also seems to have no history. Under the name of small white, Salisbury, 1848, says it bears from three to seven ears to a stalk. A lemon-yellow form is the milho pepoca, of Brazil. Sub-species C has the largest representation. It comprises the mais quarantino of France, at least in the samples I have received, and the mais nain, mais a poulet of the French; the cinquanto, sessantino and torquetto of Italy, probably. In Mexico, under mais cuarentano, Heller gives Mexican names of varieties as mais tremes and olote colorado. The golden pop group are distinguished by small size of ear and kernel and extreme earliness. Hence we may mention here, without certainty as to the species, early maturing varieties. Humboldt quotes Oviedo as having seen in Nicarauga a variety ripening in 30 or 40 days, says that he remembers finding this variety on the banks of the Amazon, and that in Hungary there is a two months' variety. Dalechamp, 1587, refers to a variety that matures in two months, and another less grown which ripens in 40 days. Porta, in his Villæ, 1592, refers to a six weeks' and two months' corn. Lery, in his Brazil, 1594, names a 45 day corn. Morison, 1699, describes from America the "Rathripe" corn. Dobrezhoffer, 1749, mentions in Paraguay, the abati miri, which ripens in a month, but has very small dwarfish grains. Catlin describes finding among the Mandan Indians an early corn with ears as long as a man's thumb. Nuttall calls this *Zea Mays præcox*, a name which Bonafous repeats for a golden pop variety. The corn of Lake Titicaca, described by Squier as dwarf and hard grained, is almost certainly a pop. The golden pop varieties when grown in pots usually develop tassel corn in my experience. Hence we note here that Parkinson, 1640, describes the Frumentum indicum alterum minus, as grown in the unfavoring English climate, as not bearing crop "at the joynts of the stalkes as the other, but at the toppes following the flowers." This variety was not known to Ray, 1688, and he doubts the description and classes with Frumentum indicum mays dictum minus, C. Bauhin, 1623. The pearl pop group is distin-

guished by the dense aggregation of the kernels and their nacre-like lustre. Molina calls it the stone maize. Samples from Rio Claro, Brazil, were labeled milho perola. In California I have seen on exhibition stalks bearing up to nine ears. The Mapledale Prolific, which seems to belong here, is figured by a seedsman in 1890, with sixteen ears on a stalk, some of the ears clustered two in an axil; an affidavit accompanying says that 10 stalks had 121 ears, and one stalk 19 ears. The rice pops are peculiar for their pointed kernels, and the tendency to yield cone-form ears with imbricated kernels. They seem ancient in Peru, as having been found in sculpture. Rivers and Tschudi say that the rice pop kind and cone-shaped ears were considered as sacred things and were buried with mummies by the Peruvians. Dobrezhoffer, 1749, says that in Paraguay the kind with pointed kernels was called bisingallo. A noticeable feature of the rice pop is the tendency to sport. Frequently half the ears of a garden crop will be flattened or digitate at their apex, and in the Bear's Foot variety this tendency has become permanent to form a flat ear. There is also a tendency in the plant to form branches, or to bear aggregate ears, or to develop tassel corn, and occasionally tassel ears. The Monarch White Rice, as advertised in 1887, is figured as bearing tassel ears and also seven ears on a stalk. When grown separately the plants usually sucker greatly. The description of the kernels of *Zea canina* Wats. as "small, white, hard and smooth, ovate, acutish, constricted at base," would apply to this class, but the "ears small, 4 to 12-rowed," offer a variety not yet known to me. His other characters, except as to the spikelets and glumes which I have not looked for, do not differ from characters to be observed in all our species as of frequent or exceptional occurrence, and especially in *Zea tunicata*. The few kernels in the herbarium specimens of *Zea canina*, presented me by Professor Watson, are distinctly of the rice pop type, and a peculiarity overlooked by Professor Watson, or more likely not present in the ears that underwent his examination, some are podded. If we reason closely from this statement, we may class *Zea canina* Wats. with my *Zea everta*, with the appearance of *Zea tunicata* as an atavism. The *Mais rosero*, a pop corn observed by Professor Duges as cultivated in the region (Mexico) where *Zea canina* was collected, we only know by name.

Some varieties of sorghum seed, such as "rice wheat," have the property of popping like pop-corn; so also the seeds of *Amarantus leucospermus* Wats., and are thus used in Mexico.

III.

Zea indurata, the flint corns, N. Y. Ex. Sta. 1884, 164: 1886, 59, *fig.*

The split kernel exhibits the chit, starchy matter, and a corneous matter enveloping. It cannot be confounded with any other species except the pop, from which it is distinguished by the larger kernel and inability to "pop."

Mays Zea Gærtn. Fr. 1788, *t. 1.;* also same figures, *Mays* Tourn. Inst. 1719. *t. 305: Zea Mays*, Lam. Ill. 1823, *t. 749, fig. h.*

Turcicum frumentum Fuchs. Hist. 1542, 825 and as copies, Fuchs, Hist. 1549, 783; 1551, 783; imag. 1545, 476; pl. effig. 1549, 476; *Milium indicum*, Dod. frugum, 1552, 35; post, 1554, 10; *Frumentum turcicum*, Lyte's Dod. 1578, 464; *Triticum Indicum Fuchsii*, Lugd. 1587, 382; *Triticum Indicum*, J. Bauh. 1650, 2, 453; *Triticum turcicum* vel *indianum*, Chabr. 1666, 174; 1673, 174.

Frumentum turcicum Blackw. herb. 1773, *t. 547.*

I find no synonyms for our vernacular "flint corn." It is the Indian corn, in yellow, red and blue or blue-mixed varieties found by the Pilgrims as mentioned by Mouart and Higginson; the Indian wheat, yellow, red and blue of Josselyn. Cartier, 1535, found two varieties in or near the present Montreal, one called offici, as big as small peas, and hence probably our Canada Twelve-rowed; the other called carracony, as great and somewhat bigger than small peason, hence the Canada Eight-rowed. Heriot, 1588, in Virginia, under the name pagatour seems to describe a flint corn. This species is probably the Mays minor, with yellow, red and blue colors, which ripens in England in four months, as recorded in Miller's dictionary, editions of 1731, 1748 and 1752; the Zea vulgare, caule humiliore, etc., of the edition of 1771, the ears 4 to 5 inches long, the kernels yellowish white, deep yellow, purple, blue and mixed, ripening in England. The Mandan Indian corn, as described by Salisbury, seems to be a flint, and a flint corn under the name of Mandan has come to me from Fort

Lincoln, Dakota.* Du Pratz, 1763, describes white, yellow, red and blue homony corn in Louisiana. The San Padro Indians of Mexico cultivate a flint variety, the Tarahumarer Indians two varieties and the Yacqui Indians one, as represented in my collections. The common corn of Honduras is described by Squier as a flint. In Guatemala, Brigham found a variety of large kernelled corn like "rice corn," a form which I have never seen. In Paraguay the Guaranies have an abati hata, 'composed of very hard grains.' In Peru, DeVega says the Indians have a hard kind called muruchu. Tschudi seems to describe a flint corn under the name morocha, and Herndon and Gibbon describe the mais morocha at Tarma as with small grain, red, white, yellow and blue, which is parched, forming cancha or "toasted maize." The Topover corn, a very distinct and peculiar variety, with eight or ten rows, was claimed to have originated in Nantucket, and was first brought to notice in 1884. In 1886, I found a yellow and a white Ten-rowed Topover in the Tarahamarer Indian collection sent me by Dr. Palmer.

I have noticed more sports in this species than in the others, because it is the one I have cultivated in my farming. I have figured in the *Scientific Farmer*, October, 1878, a tassel bearing grain, a tassel undergoing partial transformation into ear, and one converted into a tassel ear; also four ears developed in a bunch from the upper node. Mention is also made of the extremity of an ear bearing a tassel, and in the New York Experiment Station Report, 1883, 40, of an ear of New England twelve-rowed, eight inches long, then one and a quarter inches of tassel, and at the end of this tassel another well formed ear three inches long. In other varieties, a branch may occur on the leaf axil bearing a terminal ear and one or more at the nodes below, and in 1879 I had a branch with one terminal and three nodal ears. By compressing the pith of a growing plant this branching may be greatly stimulated. One variety, the Vermont yellow, is described as bearing its ear normally on a branch two feet long. Occasionally two

*May 14, 1894, Dr. Wm. Saunders, Director of the Experimental Farm, Canada, sent me a sample of the Squaw corn grown at Rat Portage, Lake of the Woods, about 50° N., which corresponds with the Mandan flint, and is a shorter and smaller ear of the common Northern New England Eight-rowed. The ear was 6½ inches long and kernels large.

ears, more rarely a bunch of ears appear at a node, but in such cases they all do not fertilize. Digitate and branching ears are not very uncommon. In some cases two ears joined at their base, in others three or more; more rarely a whole group is so joined as to form a cup lined both inside and outside with kernels. In eight-rowed varieties four-rowed ears are sometimes found, the ear then flattened and distichous. Six-rowed ears are also found, and such have a tendency to develop the rows in a spiral. In eight-rowed corn the breaking of the cob discloses a four-sided appearance; in the ten-rowed, a five-sided appearance, and so on, as I have indicated in my diagrams published in the New York Experiment Station Report for 1884. Suckering is of frequent occurrence, and is greatly stimulated by an open exposure and a highly manured soil. Japanese striped is an excessively suckering variety. In a digitate ear of Waushakum corn I once found some podded kernels, and also once in an otherwise normal ear of eight-rowed New England.

The Sorghum varieties "Dhoura," "African wheat" and "Millo maize" have a structure of kernel corresponding to the flint corn type.

IV.

Zea indentata, the Dent corns, N. Y. Ex. Sta. 1884, 172; 1886, 59, *fig*.

The split kernel exposes the chit, corneous matter at the sides, the starchy matter extending to the summit.

Turcicum frumentum Dod. frum. 1566, 74, and also as copies; *Milium Indicum* Lob. obs. 1576, 24; *Frumentum turcicum* Dod. pempt. 1583, 500; 1616, 509. *Milium Indicum Plinianum* Lob. ic. 1591, 39; *Frumentum Asiaticum* Ger. 1636, 81; *Milium Indicum maximum*, Park. th. 1640, 1138; *Triticum Peruvianum album longum III*, J. Bauh. 1650, 2, 454; *Triticum Peruvianum* Chabr. 1666, 174; 1677, 174.

Frumentum indicum granis luteis Weinm. phyt. 1739, *t. 518.*

Frumentum seu milium indicum granis rubentibus Weinm. l. c.

I find no vernacular names for this species other than "dent" in America. A soft corn, through rapid drying, may form a crease or a dent in its kernel, but a split kernel, which at once

shows absence of corneous matter, determines the species. The dent corns furnish the bulk of our commercial supply for home use and export. The varieties grown for this purpose belong almost exclusively to sub-species C., and often have very many rows, even to the number of forty-eight. The poketawes or hokotawes of the Powhattan Indians, 1608, was a horse-tooth dent. The most northern locality represented in my collection is North Dakota, an eight-rowed form, sub-species A. The amarillo of Peru, as described by Tschudi, I take to be a dent. In a Chilian collection kernels with corneous sides and sweet at summit indicate the presence of dent corn in that country. The *milho catete vermelho*, of Brazil, is a dent.

The Early Adams is a variety in which the irregularity of the kernel arrangement is characteristic. The Extra Early Adams, sub-species C., is reported as ripening at Ottawa, Canada. One variety grows from African flint seed, through atavism, had kernels armed with a short, sharp, stiff spine where the silk was attached, but this peculiarity was not reproduced in the growing. A red-husked dent is sold by our seedsman, and from Dr. Palmer, in 1886, I received two red-husked varieties among seven dents collected from the San Padro Indians of Mexico. Some varieties are described as bearing many ears to a stalk, seven to eight in the Baden, six to eight for Blount's Prolific. I have seen as many as nine good ears on a stalk of this variety. These varieties are also much subject to suckering, as seems also the Chinese tree-corn, which is described as branching. The formation of adventitious roots is very noticeable in this species, although not confined to the dent group. There is also a strong tendency in the dent for the ears to hang downward at maturity, thus protecting the kernels from the weather. From Dr. Palmer I received from the San Padro Indians one sample, five almost bunched ears, the terminal one about five inches long and kernel-bearing, and within a space of three inches below were four alternating unfruitful ears. As will appear elsewhere, we have noted the appearance of podded ears on the normal *Zea tunicata*, in a crop of Blount's Prolific.

In the variety of Sorghum called "Neeazana" we have a structure of kernel similar to the dent corn.

V.

Zea amylacea, the soft corns, N. Y. Ex. Sta. 1884, 181 ; 1886, 59, *fig*.

The split kernel shows only the chit and starchy matter, corneous matter being entirely absent.

Zea erythrolepsis Bonafous, mais, 1836, 30 (Tuscarora).

Zea macrocarpa Klotz. Bot. Zeit. 1851.

Maizium, Peter Martyr, 1493, in Eden's Hist., Trav. 1577, 10.

Frumentum turcicum Dod. frugum, 1552, 35 ; Lyte's Dod. 1575, 464. The same figures, *Triticum indicum*, J. Bauh, 1650, 2, 453.

Frumentum Indicum Matth. comm. 1570, 305 ; Calceol. 1571, 164 ; the same figure, *Triticum indicum* Matthioli, Lugd. 1587, 1 : 382.

Frumentum Indicum Cam. epit. 1586, 181. The same figure also in Uffenb, 1609, 398 ; Becher, 1662, 147 ; Verzasch, 1678, 172 ; Zwing, 1696, 323.

In my collections this species shows a greater variety of shades and colors than any of the others, and is the principal sort grown by the Indians of Mexico. Hence we can refer to Hernandez, who in his history, 1651, mentions white, pale, black, purple, yellow, blue and mixed colors ; also a very long ear with glistening white, large and tender seed, as Mexican varieties. His figure under Tlaolli seu maizio, p. 242, is the same as *Aliud milium indicum magnum* Lob. ic. 1591, 40, and *Frumentum turcicum* Ger. 1636, 81. His Tlaolli seu maizio, p. 243, is the same figure as Milium indicum rubrum, Lob. ic. 1591, 40, and Frumentum indicum luteum, Ger. 1636, 82. Tabernæmontanus in his history, editions of 1588 and 1613, and Icones, 1590, figures under *Frumentum turcicum* five varieties which may be flint ; under *Frumentum indicum* fourteen varieties, black, purple, blue, red, yellow, white, mottled, variegated and many-colored, and the figures suggest a soft corn. The same figures appear in Gerarde's herbal, 1597, but the names badly transposed or different. *Frumentum Indicum* Tabern. 1588, 760, 761 ; 1613, 641 ; ic. 1590, 265, is copied in Bauhins' editions of Matthiolus, 1598, 319 and 1674, 319 ; in Gerarde, 1597, 75, called *Frumentum Asiaticum* ; in the second edition of Gerarde, 1636, 75, it is called *Frumentum Indi-*

cum cæruleum; in Bauhins' theatre, 1658, 459, *Frumentum indicum mays dictum alterum;* and an apparent copy in Morrison oxon. 1699, s. 8, *t. 13, f. 1*, is labelled *Frumentum indicum mays dictum.* Peter Martyr, in his first decade, written in 1493, describes the maizium of Hispaniola as a black, pea-size grain, which when broken is "whiter then snowe," and hence a soft corn. De Vega, in his Royal Commentaries, says the ancient Peruvians had a sort called capia, "tender and highly esteemed." The mummy corns that I have seen from Peru have been soft corns. Dobrezhoffer says the Guaranies of Paraguay had an abati moroti, which consists of very soft and white grains. The maize found by Darwin imbedded with shells and rubbish on a terrace 85 feet above the beach in Peru, he declares identical with the kind found in the Peruvian huacas. In the Tusayan pueblo (New Mexican) flute ceremonial legend, as given by Matilda Coxe Stevenson, occurs the following passage: "He then placed a yellow ear of corn to the north of the bowl, a blue ear to the west, a red ear to the south, and a white to the east; a black for the zenith was placed by the side of the yellow ear, and the all-color for the nadir by the side of the red ear." In these colors we seem to recognize soft corn, especially as in the Zuni collection of soft corn we have these colors, and the same varieties in the same color I have seen in soft corn brought to Santa Fé by tourists from the Tesuque pueblo, nine miles distant. Du Pratz, in his history of Louisiana, 1763, mentions as a variety "flour maiz, which is white, with a flat and shrivelled surface, and is the softest of all kinds."

The soft corns have a wide distribution, and seem to have been popular with Indians, as the kernels are readily broken down into flour. I have recognized it from Manitoba in the North; in specimens from the cliff dwellings and as in cultivation in eleven varieties by the Southwestern tribes; in the Omaha corn of Nebraska; the Squaw corn of Michigan; the Wyandotte of Illinois; in the Tuscarora in three colors from North Carolina; in Mexican Indian corn in thirteen varieties; in the maizium described for the West Indies; in two varieties described in Peru; in the mummy corn of Peru; in five varieties from Chili, including the Cuzco. This latter is the largest kerneled corn known, some collections

showing kernels an inch long, correspondingly broad and thick. It is described as having many varieties, and five colors are named by Markham.

But few sports have come under my observation. In 1885 an ear of Zuni yellow was grown with a tassel protruding from the apex. The Wyandotte suckers so freely as to be said to tiller like wheat; it also bears many ears to a stalk; one sample from the San Padro Indians had a branch with one terminal ear, and four ears bunched a short distance below.

The variety of Sorghum called "Chinese sugar cane" has seed floury throughout and without corneous matter, like the soft corns.

VI.

Zea saccharata, the sweet corns. N. Y. Exp. Sta., 1884, 156; 1886, 59, *fig.*

The kernel of this species has a semi-transparent or translucent, horny appearance, and is more or less crinkled, wrinkled or shrivelled.

Zea mays rugosa Bonafous, Mais. 1836, *t. 11.* (An eight-rowed sweet.)

The earliest reference to sweet corn that I find is in the Zuni myth, as given by Cushing, quoted by Harshberger, where it is said that the oldest sister was yellow corn; the second, blue; the third, red; the fourth, white; the fifth, speckled; the sixth, black; the seventh, sweet corn. The six colors were in the Zuni collection sent me by Mr. Cushing, but there was not a sweet corn among them. The first sweet corn in American cultivation was the papoon corn, an eight-rowed variety with a reddish cob, first introduced to the region about Plymouth from the Indians of the Susquehanna in 1779. It belonged to sub-species A. Tschudi, who was in Peru 1839–42, describes a sweet corn apparently of sub-species C., under the name *Amarillo de chancay.* The Black Mexican was described by Bârr in 1863, its name indicating origin. Under this name two varieties are now grown, one of sub-species A, the other of sub-species B.

The distribution into culture was slow. It was not mentioned by Jefferson in his notes on Virginia in 1781, nor by writers on

American gardening in 1806, 1817, 1818, 1819, 1821 and 1828; nor by Seringe for Switzerland in 1818; nor by Metzger for Germany in 1824; nor by Noisette for France in 1829. Bridgeman mentions one variety in 1832, as does Buist in 1851. The original eight-rowed form, and another like it, but with a white cob, is mentioned in 1853; in the Patent Office Report, 1853, the Mammoth Sweet and Stowell's Late Green are named. Schenck, 1854, knew two varieties; Klippart, 1858, six varieties; Burr, 1866, twelve varieties. In the New York Station Report, 1884, I described and figured thirty-three varieties. One variety, the Ruby Sweet, of recent introduction, has red husks.

Sweet corn kernels are usually all corneous; sometimes, however, a small quantity of starchy matter is visible. I suspect that a fuller study may unite the sweet corns as variety forms of pops, flints and dents. In the New York Station Report, 1884, 131, mention is made of some kernels flint on the chit face and sweet on the opposite face. Then, again, in my Chilian collection were some kernels corneous at the sides and sweet on the summit. My *Zea amyleasaccharata* may perhaps be also mentioned as a form of variation. I have observed but few monstrous growths. I once received a plant of Stowell's Evergreen but 12½ inches tall, well formed, of vigorous green, leafy, and bearing three unripe ears, two of which were kernelled. These two ears were hermaphrodite, the ovule and stamens within the same glume. We have also record of podded kernels being found in a crop of this species.

VII.

Zea amyleasaccharata, the starchy-sweet corns. N. Y. Ex. Sta. 1886, 60, *fig.*

This species is founded upon three varieties found in the San Padro Indian collection of Dr. Palmer and sent me in 1886. The external appearance of the kernel is that of a sweet, but examination shows that the lower half of the kernel is starchy, the upper half horny and translucent. These varieties had all a white cob, the kernels deeper than broad, or sub-species C.

1. Ear fusiform, kernels rounding towards a small stalk, 7 inches long by 1¾ inches in diameter at largest part, 16-rowed.

Kernels translucent yellow, flat at summit, deeply shrunken at top and sides, no sulcus between rows. The most attractive sweet corn I have ever seen.

2. Ear fusiform, rather pointing at tip, kernels rounding strongly towards a smallish stalk, 5 inches long by 1⅞ inches in largest diameter, 18-rowed, kernels much deeper than broad, very thick, wrinkled, of a translucent yellow. No sulcus between rows.

3. Ear slightly fusiform, kernels rounding gradually to a small stalk, 5 inches long by 1¾ inches in largest diameter, 16-rowed. Kernels translucent yellow, quite golden, wrinkled. A deep sulcus between the rows.

The crop failed to mature at Geneva, N. Y., and thus the seed was lost. The plants grew very tall, and were only at the bloom when fall frosts came.

VIII.

Zea tunicata, the Pod corns.

In this species each kernel is enclosed in a pod or husk, and the ear thus formed itself enclosed in a husk.

Zea mays tunicata St. Hil. Ann. Sc. Nat. **16**: 143, fide DeCand.

Zea cryptosperma Bonafous, Mais. 1836, *t. 5*.

Zea mays vaginata, N. Y. Ex. Sta. 1884, 186, *fig.*

Frumentum indicum grano avellano magnitudine, C. Bauh, 1623, 24; J. Bauh, 1650, 2, 454; Moris, Oxon. 1699, 3, 248.

Frumentum indicum majus grano avellanæ, C. B., J. B., Moris, Oxon. 1699, 3, s. 8, *t. 13, f. 2*.

Æthiop Manigette, Mentz. Index, 1682, 122.

The vernacular names I have noticed are: California corn, Cow corn, Forage corn, Husk corn, Oregon corn, Pod corn, Primitive corn, Rocky Mountain corn, Texan corn, Wild corn. In Africa, manigette (C. B., 1623); in Buenos Ayres, pinsingallo (Bonafous).

The Bibliography of this species, additional to that given in the list of synonyms, is as follows: Teschemacher, Proc. Boston, Soc. of Nat. Hist., Oct. 19, 1842; Lindley, Jour. Hort. Soc. 1846, 115, *fig.*; Salisbury, Trans. N. Y. Agr. Soc. 1848, 837; U. S. Pat. Office Report, 1853, 98, *fig.*; DeCandolle, Geog. Bot. 1855, 951; Orig. des Pl. Cult. 1883, 316; Klippart, Agr. of Ohio, 1858, 84.

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fig.; Darwin, An. & Pl. under Domes [1868] 1, 386; Carman, Moore's *Rural New Yorker*, Mar. 3, 1877, *fig.*; Sturtevant, Trans. N. Y. Ag. Soc. 1879, 37 and reprints or excepts, 1879, 21; 1880, 21; N. Y. Ex. Sta. Reports, 1882, 54; 1883, 40; 1884, 142, 186, *figs.*; 1885, 95; 1886, 64; Science, 1883, 1: 234; Wittmack, ueber anteken mais, etc., in Berlin, Anthrop. Ges. Nov. 10, 1879; Landreth Seed Catalogue, 1889, *fig.*

DeCandolle, who investigated its history up to 1835, quotes the Abbe Larranhaga as saying that the Guaycurus Indians cultivate it, but according to St. Hilaire this tribe is not agricultural. A young Guarany, who recognized this maize, said that it grew in the humid forests of his country. Bonafous received the seed from Buenos Ayres under the name pinsingallo. Lindley received seed from New York said to have come from the Rocky Mountains. C. Bauhin, 1623, gives an African name, manigette. The seed is occasionally supplied by our seedsmen as a curiosity for growing in the garden, and doubtless the names California corn, Oregon corn, Rocky Mountain corn and Texan corn indicate sources from which seed have been procured, but without necessarily implying origin. It is very rarely grown even by the curious, and but few farmers have seen it. A Mr. Bullard, of Ohio, on seeing some specimens for the first time, expressed surprise at the ear, but said he had frequently found single kernels podded in his crop of dent corn. May 18, 1884, J. W. Nicholson, Camden, N. J., wrote me that he had now planted Blount's Prolific [dent] corn, the original seed from the Department of Agriculture at Washington for four years, and that each successive year he had found more and more pod corn in his crop. The samples he sent me were ears of fully podded corn of the Blount's Prolific type. December 9, 1885, I received a number of ears of a podded flint corn from Ohio, and one of these ears had kernels twinned in the pods. In the specimens of *Zea canina* sent me by Professor Watson, I note kernels of podded corn of the rice pop type. In *Science*, 1894, 109, is an account of "an ear each grain of which had a distinct shuck" from a planting of "ordinary sugar corn." I have myself found podded kernels on a digitate ear of Waushakum flint, and also on an otherwise normal ear of a common New England eight-rowed flint, and have raised podded sweet

kernels from a white dent ear raised from a red unpodded ear of pod corn. From yellow dent seed, sub-species C, were grown sweet, flint and dent corns with the podded character, and sweet, flint, dent and soft corn in unpodded ears. The variables noticed were tassel corn, ears with kernels uniformily and lightly husked, heavily husked, fastigiate ears, unpodded ears, cone-shaped ears, cylindrical ears; kernels white, yellow, red and striped. From podded seed, 166 plants yielded 76 podded and 29 unpodded ears and one tassel ear. The presence of smut diminished the yield to a large extent. The number of rows on unpodded ears varied from 12 to 24.

The description of the dent plants bearing the podded ears is: Strong growing, ordinarily from 8 to 10 feet tall, exceedingly leafy, inclined to sucker, adventitious roots at lower nodes, the crop borne about four feet from the ground, on the fifth to seventh node from the top. Tassel very heavy, the branches long and drooping, not rising very high above the foliage, very frequently kernel bearing, the grain either bare or podded. Ears variable in length and form. In the heavily podded samples the cone shape with imbrication is prevalent; as the podding becomes lighter the ears tend more towards the cylindrical, but even in wholly unpodded ears the cone-shape occasionally persists. In some cases a fastigiate group of husked ears at the but, changing to heavily podded kernels as we near the tip; in other cases the outer husk embraces a whole cluster of ears, which in our growing were too late for crop. Cobs in the heavily podded ears very flimsy, when dry tending to break readily into short pieces; in the fastigiate specimens even more flimsy; in the lightly podded forms larger and less loose, even to the ordinary hard and dense cob of the common form. Kernels in heavily podded samples, being removed from pressure, are more rounded than in their unpodded form, and often distinctly pointed towards the place of insertion on their cob, the distichous arrangement often very pronounced; occasionally two or even three kernels in a common pod. The corneous matter is very hard and flinty. The pods are variable in length, usually white, occasionally brown or red-tinged.

In favor of *Zea tunicata* being closely allied to a primitive form we may call attention to the appearance of podded kernels on ears

of our other species, as recorded here for pops, flints, dents and sweets, which suggests atavism; to the flimsiness of the cob and its occasional readiness to disarticulate; to the tendency towards fasciation or clustering in the ears; to the hardness of the corneous matter in the kernels; to the protective character of the pods as against insect and bird depredation, as favoring distribution of the seed under natural agencies, as favoring germination, through retention of moisture of seed dropped on the surface of the ground, as protective against weevil infection. It is almost certain, says Darwin, that the aboriginal form would have had its grains thus protected.

As a wild plant this species has been insufficiently recorded from Paraguay, and also in the form of *Zea canina* from Mexico. Heller writes: "We often find in Mexico single plants of maize which grow self-sown, and flourish without culture; and though they may stand miles from any inhabited place, they cannot be considered wild, as, notwithstanding the often monstrous variety, they always bear the characteristics of cultivated maize." Professor Watson quotes Professor Brewer's letter to me, in which he says that a well-known German collector, a Mr. Roezl, told him in 1869 that "he found in the State of Guerro a *Zea* which he thought specifically distinct and undescribed, the ears very small, in two rows, truly distichous, the ear (but not each grain separately) covered with a husk, the grain precisely like some varieties of maize, only smaller and harder." Professor Watson thinks this probably the same as his *Zea canina*. Professor Duges, in sending this mais de coyote to Professor Watson, mentions that "a pop corn, mais rosero," is cultivated in the same region, a fact of some significance.

We hence are inclined to believe that when a truly wild *Zea* is discovered it will be of a podded form, the kernels small and very flinty. It will be recalled that in our trial of vegetations pop corn seed held the supremacy, and that pop corns showed the strongest vitality in regerminations after air-drying.

IX.

When we consider the number and the perfection of the varieties of maize, we cannot but recognize that a long antiquity and

extended cultivation were requisite for their differentiation. For various reasons I am disposed to consider *Zea everta*, of our cultivated species, the nearest to the primitive form, and *Zea amylacea* as the furthest remove from the primitive form; the Cuzco corn of Peru and Chili the most improved class of variety. The next most highly developed varieties seem to be the horse-tooth softs of Chili. The largest number of species represented in any one Indian collection is four, in fifteen varieties, from the San Padro Indians of Mexico, seventeen ears which excelled in perfection of form any like number collected from any one locality or from seedsmen. The next largest number of species is the three, in eight varieties, from the Tarahumarer Indians of Mexico, "the timid Tarahumari," as Harshberger quotes, "a savage race, living mostly on the cliffs, and planting a little corn without cultivation on the steep hillsides, and not otherwise tillers of the soil." It is unfortunate that our collections from South America are so limited, as Peru excels in species and varieties noted in the table gleaned from our readings.

If we look upon agriculture as a pursuit which yields a food supply requisite for the maintenance of a population, then the American Indian was an agriculturist wherever with suitable climate tribal strength or location availed to protect his crops. When Gen. Sullivan, in 1779, made his invasion into the Indian country of Central New York, the Indians were subdued through the destruction of their food supplies rather than through their losses in battle. In perusing the journals of this expedition we find continual mention of the seizure of corn, of large fields, of abundance of corn, and at the present Genesee the destruction of 20,000 bushels. In the earlier invasion of this region by De Nouville, in 1687, some 1,200,000 bushels of corn are said to have been destroyed, and in 1696 Frontenac, in the country of the Onondagas, employed his army for three August days in destroying the growing corn, which extended from a league and a half to two leagues from the fort. In the Pequot war, in 1636, the English destroyed 200 acres of corn on Block Island, R. I., alone; and in the King Philip war, in 1675, the Puritans harvested a thousand acres as spoils.

When Cartier reached Hochelega, the present Montreal, in

1535, he found the town surrounded by extensive cornfields. In 1605 Champlain mentions fields of corn at the mouth of the Kennebec river and along Cape Cod. In 1609 Hudson found "a great quantity of maize" among the Indians of the river of his name. The Pilgrims, in 1620, found "fifty acres" of field in one place, and "new stubble" elsewhere in their early reconnoisance of their country. In 1634 John Oldham bought 500 bushels of the Narragansett Indians, who had promised him a thousand. In 1747 Cobden says the Five Nations made planting of corn their business and supplied more northern tribes, and in 1794 Gen. Wayne wrote of the Delawares, of Ohio, "nor have I ever before beheld such immense fields of corn."

In the early settlement of America every European colony seems to have been dependent upon corn bought or seized from the Indians, and every march of invasion was rendered possible by the corn found in the Indian granaries or taken from the growing plants. De Soto's march from the east discloses corn in crops throughout his course, as did Coronado's march from Mexico to Kansas, wherever climatic conditions permitted.

Columbus found maize in the West Indies on his first voyage, in 1492. In 1498 he reports his brother passing through eighteen miles of cornfields on the Isthmus, and the same year he found maize in Venezuela. At Zobabra, 1503, Diego Bartholemew saw above six leagues of cultivated corn. Cornfields and corn are also mentioned in Central America by Pascual de Andagoya in 1516. In 1518 de Encica mentions maize and roots as constituting the food of the Amazons, and in 1520 the ships of Magellan were supplied with maize at Rio Janeiro. Cieza de Leon, who travelled in Peru, 1532–50, continually speaks of fields of maize, as do more modern travellers, and the remains of irrigation conduits attest the antiquity and extent of its culture. Thevet, 1558, describes maize in Brazil, as does Lery, 1594, and Nieuhoff in 1647. In Chili maize was the ordinary diet, as Alonzo de Ovalle wrote in 1649. In Mexico the sixth and seventh centuries of our era represent the Toltec period, and the Olmecs are thought to have raised maize before the time of the Toltecs.

The antiquarian evidence is the finding of charred corn and cobs in Indian mounds in Ohio, Missouri and elsewhere, and in

the ears and grains found enclosed with the mummy burials in Arizona, New Mexico and Southern Utah. Charnay reports representation of ears of maize on some ancient statuary in Mexico. Brocklehurst figures the vase of Centeotl with its ear of corn, and hieroglyphics on the monuments at Palenque indicate that maize was an important food in Yucatan. The Smithsonian Institute has an ear of corn found in an earthen vessel eleven feet under ground in a mummy grave near Arequipe in Peru. Tschudi describes two kinds taken from tombs apparently prior to the dynasty of the Incas. Squier found not only the grain, but an ear carved out of a variegated talc within a mummy covering at Pachacamac, where also spikes of maize were observed by Pickering. A harvest vase of maize from the ruins of Chemu, near the present Truxillo, shows the heads of children peeping out among the corn cobs, as Markham writes. In 1835 Darwin found on the coast of Peru heads of maize together with eighteen species of recent sea-shells embedded in a beach which had been upraised at least eighty-five feet above the level of the sea, and these relics he pronounced identical with those taken from old Peruvian tombs. At Tarapaca, in 1874, beneath the volcanic formation called Chuco, were found cobs of maize buried with a mummy.

In what locality did the cultivation of maize originate. Our data is as yet too imperfect for reply, as we have little record of the varieties that are at present grown either in Peru or Mexico, between which places our choice seemingly is to be made. The evidence of the more ancient presence of maize in Peru in the finding of specimens in geological deposits is superior to that tabulated for Mexico. The finding of a wild corn (probably an escape) in Mexico, is a little more certain than the Indian testimony of wild corn in Paraguay. The superior development of varieties, as the Cuzco of Peru, and the Cuzco and horse-tooth soft forms of Chili, is strong evidence in favor of a South American origin. The rice pop found in Peruvian sepulture, and as growing in Paraguay, is also in evidence; but the rice pop form is present in *Zea canina* of Mexico.

The antiquity of the culture must be great as measured by years, for Darwin's variety from a geological deposit was pro-

nounced identical with that buried with the ancient Peruvians, and this corn, so far as we have seen it, is *Zea amylacea*, the most divergent of our species from the primitive form; but *Zea everta*, rice form, is the least divergent and is also found among the relics of the tombs. So the indefinitiveness of mention, even by such an eminent observer as Darwin, leaves uncertainty.

X.

The environmental relationships of maize seem to have been but little studied, and are very obscure. Seed sown on the surface, through the property of regermination, will frequently vegetate, as will also seed sown at a depth of eight inches or more. When the seed is planted in ground of a low temperature, although the germination process will go on at 42° or 43° F., yet the progress is so slow that mould often destroys vitality before vegetation can occur, while at a high temperature progress is so rapid that this danger is escaped. In the *Scientific Farmer*, October, 1878, I called attention to the embryo ears on a cornstalk, and gave a figure. These embryo ears usually all but one remain dormant when the crop is close planted, but are inclined to develop as openness of planting increases. By mutilating the plant in various ways these dormant ears may be stimulated into development, the lower ones especially, into branches with a terminal ear. Compressing the upper portion of the stalk is often followed by kernel formations on the tassels, and a ligature applied to an ear has been followed by the development of a tassel on the extremity. Suckering in the corn plant is the development of dormant buds, and is furthered greatly by openness of planting and fertility of soil, although in some varieties, like the Wyandotte soft and the Japanese striped flint, it becomes a characteristic which can scarcely be checked. The relation of the plant to climate is difficult to define. The influences often ascribed to climate seem usually to be the result of a variety characteristic, or changes induced by unconscious selection. Some Mexican Indian corn was represented to me by Dr. Palmer as growing to about the height of a man, and as being early maturing. Planted in New York in May, the plants were about eleven feet tall and just approaching bloom in October when cut down by frost.

Zea canina, as grown at Cambridge by Professor Watson, was ten feet tall, and suckered greatly; as grown by Harshberger, at Philadelphia, it was but five feet tall, and tillering is neither noted nor figured. Moisture seems to develop height, aridity to dwarf. When weeds, the great robbers of moisture from land, are allowed to develop freely in a cornfield, a moist spot will frequently bear corn of the normal height, while a neighboring drier hillock yields only dwarfed and stunted specimens. On the other hand some varieties seem to remain dwarf under all conditions observed. The tallest forms are recorded from hot and moist tropical regions, but so also are low-growing varieties.

Contributions to American Bryology.—VIII.

By Elizabeth G. Britton.

A REVISION OF THE GENUS BRUCHIA, WITH DESCRIPTIONS OF TYPES, AND ONE NEW SPECIES.

(Plates 213–217.)

BRUCHIA Schwægr. Suppl. **2**: 91 (1824).

PHASCUM Schreb. De Phasco Obs. (1770) in part.

SPORLEDERA Hampe, Linnæa, 279 (1837).

The genus *Bruchia* was founded by Schwægrichen in 1824 for *B. flexuosa*, which had previously been described under *Phascum* from specimens sent by Muhlenberg. The type species, therefore, is American, and the genus reaches its greatest development in North America, only two European species being so far known. Several have been described from Central and South America, and three from South Africa.

Müller in his Synopsis Muscorum, 1849, recognized 7 species, of which four were American, and subdivided the genus into two sections:

I. Sporledera Hpe. (*B. Beyrichiana*, *B. palustris*, *B. brevipes*).

II. Eubruchia. (*B. flexuosa* and var. *minor*).

In the first section he placed the subacaulescent species, and in the second the taller, stemmed species with exserted capsules and long necks.

Jæger, in his Musci Cleistocarpi (1869), recognized two genera.

I. *Sporledera* Hpe. (*S. palustris*, *S. Beyrichiana*, *S. Ravenelii*, and *S. setifolia* from North America, and three exotic species).

II. *Bruchia* Schwægr. (*B. brevipes*, *B. brevifolia*, *B. microcarpa*, *B. flexuosa* and *B. Bolanderi* with four exotic species).

He divided the genus *Bruchia* into two sections:

A. *Garckidium* (*B. brevifolia*, *B. brevipes* and two exotic species).

B. *Eubruchia* (*B. flexuosa*, *B. microcarpa* and *B. Bolanderi* with one of the European species).

When Sullivant's Mosses of the United States was published in 1856, he recognized five species in this genus: *B. flexuosa*, *B. Beyrichiana*, *B. brevipes*, *B. brevifolia*, and *B. Ravenelii*, with *B. palustris* under *Pleuridium*.

In the Icones Muscorum (1864) he figured four of these: *B. flexuosa*, *B. brevipes*, *B. brevifolia*, and *B. Ravenelii*. Of *B. Beyrichiana* he secured an original specimen from Hampe, and states that this species is "an immature state of *B. brevipes*."

In the Supplement to the Icones (1874) he changed his mind about *B. Beyrichiana*, and figured it, not from the original specimens, however, but from those collected by Ravenel on the Santee Canal. He also added *B. Bolanderi*, making six species in all.

Ten years later, in the Manual, Lesquereux and James recognized fourteen species, including *B. palustris*, adding four of Austin's species, *B. Sullivanti*, *B. Hallii*, *B. Donnellii*, *B. Texana*; two of their own, *B. brevicollis* and *B. curviseta*, and a Chilian species which never should have been included, *B. Hampeana* Müller.

Since then Prof. Eaton has described one new species, *B. longicollis*. Illustrations of most of these have been published. Plates of Austin's four species have been drawn for this contribution from the original specimens in his herbarium. *B. curviseta* L. & J. has not been figured, but it is very close to *B. Texana*, and the type specimens in James' Herbarium are not accessible.

In this contribution we have limited the name *B. flexuosa* to the type species, reduced *B. brevicollis* to it, rejected *B. Beyrichiana* as a mixed and uncertain species, limited the name *B. brevipes* to the African species and replaced it for American specimens by *B. Drummondii*, discarded *B. Hampeana*, a Chilian species, maintained

B. Carolinæ, and added *B. fusca* as a new species. Besides this, two other North American species, *B. microcarpa* and *B. setifolia*, still remain uncertain. They were described by Jæger from manuscript names of Wilson, but the specimens in Wilson's Herbarium do not agree with those in Jæger's, and though they probably antedate some of the more recent species, we cannot prove it. We have also learned of another species in the herbarium of Dr. C. Müller, which was collected in Alabama by Dr. Chas. Mohr, whose name it bears, but we have seen no description nor specimens.

It will be seen from the following pages that the specimens and their names have been very much confused, and it has only been through an extensive series of comparisons, drawings and measurements that we have been able to settle a few of the doubtful species.

Through the kindness of M. Eugene Autran and the authorities at Kew and South Kensington I have been able to see all the available European types. By the kindness of Dr. Robinson, Sulivant's whole collection of the genus was placed at my disposal, and Prof. D. C. Eaton also conferred on me a similar favor. Dr. S. E. Jelliffe has verified all my spore measurements.

A thorough examination of the specimens in Wilson's and Hampe's herbaria at South Kensington, London, would probably throw more light on some of the doubtful points, and as we shall show, Dr. Müller could, if he would, settle two others. We still feel that more study is necessary to properly understand the genus, and we would ask collectors in our Southern States to pay particular attention to it, as even yet more new species may be looked for.

Classification.

I. Eu-Bruchia. Neck of the capsule equal to or shorter than the spore-sac; seta immersed or very slightly exserted; lid not differentiated.

a. Caulescent species.

1. Paroicous Leaves subulate, more or less papillose; spores spinose. (*B. flexuosa, B. Sullivanti, B. Texana, B. curviseta, B. Donnellii.*)

2. Autoicous. Leaves short, smooth, erect-appressed, concave, clasping, vein not excurrent into a subulate point; spores reticulate or pitted. (*B. Hallii, B. fusca.*)

b. Acaulescent species. Autoicous. Leaves subulate, smooth, serrate or dentate; capsules almost sessile.

1. Spores reticulate. (*B. Drummondii, B. Ravenelii.*)

2. Spores pitted. (*B. brevifolia, B. Carolinæ.*)

II. TREMATODONTOIDEÆ. Neck of the capsule longer than the spore-sac; seta much exserted, lid differentiated but not dehiscent. Spores papillose. (*B. Bolanderi, B. longicollis.*)

III. SPORLEDERA. Capsule without any neck, rounded at base, immersed on a very short seta; calyptra small apical. (*B. palustris.*)

KEY.

Neck shorter than the spore-sac, or equal to it; lid undifferentiated; seta immersed or slightly exserted.
Caulescent, paroicous; seta 3–5 mm. long, exserted.
Leaves 1–3 mm. long, subulate, awn smooth or papillose.
Spores spinose, .025–.035 mm.; calyptra smooth.
Capsule ovoid, neck short, leaves nearly smooth.
1. *flexuosa.*
Capsule elongated, neck long; leaves subpapillose.
2. *Sullivanti.*
Spores reticulate, .035–.045 mm.; leaves subpapillose.
Plants 5 mm. high, seta erect, neck large.
3. *Texana.*
Plants 2–3 mm. high, seta curved, neck contracted.
4. *curviseta.*
Spores papillose, .032–.037 mm.; leaves papillose.
5. *Donnellii.*
Leaves short, smooth, not subulate, vein ending in or below the apex. Autoicous.
Spores papillose, .030–.045 mm.; leaves ovate-lanceolate.
6. *Hallii.*
Spores pitted, .020–.027 mm.; leaves triangular.
Apex acuminate, vein percurrent, capsules orange above.
7. *brevifolia.*
Apex blunt, vein ending below it, capsules brown.
8. *fusca.*
Acaulescent, 1–3 mm. high, autoicous; seta and capsule immersed.
Spores reticulate, .025–.035 mm.; capsules orange-colored.
Leaves slender, serrate; calyptra smooth.
9. *Drummondii.*
Leaves spinose-serrate; calyptra papillose.
10. *Ravenelii.*
Spores pitted, .024–.027 mm., calyptra papillose.
11. *Carolinæ.*
Neck equal to or longer than the spore-sac, lid differentiated but not dehiscent; seta long-exserted. Spores papillose, .020–.025 mm.; calyptra smooth.
Leaves short, acuminate, serrulate; neck abrupt.
12. *Bolanderi.*
Leaves short, subulate; neck tapering.
13. *longicollis.*
Neck none, the base of the capsule rounded; calyptra small, apical.
14. *palustris.*

1. BRUCHIA FLEXUOSA (Schwægr.) Müller.

Phascum flexuosum Schwægr. Suppl. 2: 1, *t.* 101 (1823), excluding *figs. 3 and 8.*

Bruchia flexuosa Müller, Bot. Zeit. 5: 99 (1847).

Bruchia Beyrichiana Sull. Icon. Suppl. 25, *t.* 15 (1874); L. & J. Man. 47 (1884).

Bruchia brevicollis L. & J. Man. 47 (1884).

Phascum flexuosum Sw.; Muhl. Cat. 98 (1813)? Name only.

Muhlenberg's Catalogue cites Swartz as the authority for this species, but without reference, giving the name only. Mr. J. H. Redfield searched, at my request, in Muhlenberg's Herbarium for the specimens, but no mosses could be found in the collection. The specimens he sent to Schwægrichen, which were described and figured in the Supplement must stand as the types, as shown by the following description.

> "*P. flexuosum* Muhlenberg Catalogus Plantar. Americæ Septentr. p. 98.
> "In terra nuda Pensilvaniæ lectum misit beatus Muhlenberg."

These specimens are preserved at the Boissier Herbarium at Geneva, and through the kindness of M. Barbey and M. Autran we have been permitted to examine them.

There are six separate plants, pasted on a sheet of paper, at the botton of which is written, "*Phascum flexuosum* Pensilv.," and above is a drawing of a cucullate calyptra like the one figured in Fig. 8. The plants bearing fruit are three in number, two of them nearly 5 mm. high, with stems simple, the lower leaves rudimentary, the upper crowded around the seta, reaching to the base of the sporange in two of them, and to the apex or a little beyond it in the third, which is less mature than the others. The leaves are erect or slightly secund, 1.5–2 mm. long, slightly broad at base, suddenly contracted into a straight or flexuose awn, roughened on the back by the thickening of the short transverse walls of the vein, serrulate at apex, ending in three longer, clear cells; vein thick, broad, nearly filling the whole of the awn; cells of the basal blade rhomboidal, becoming lax oblong at base, and sometimes serrate at apex, below base of the awn. Monœcious, the anantheridia in the axils of the upper leaves, near the perichætium, one or two, without paraphyses. Seta erect or slightly curved (two erect), 2 mm. long, vaginule brown, capsule 1–1.5 mm. long (one immature), yellow, or brown when mature, ovoid, apiculate, beak sharp, straight, neck short, dense, ending abruptly at the base, stomatose, spores .025–.035 mm., rough, spinose.

The calyptra is not preserved with the type, and the one figured (Schwægr. Suppl. 2: 1, *t. 101, fig. 8*) seems to belong with Fig. 3 to a *Pleuridium* rather than a *Bruchia*. It is described in the text

"Calyptra campanulata, angusta, latere fissa, vix dimidio minor quam capsula."

It is probable that there was a mixture in the original specimen. It should be noted, in support of this view, that the base of the capsule in fig. 3 is abrupt, while in figs. 2 and 7 it has a distinct neck; also that it protrudes laterally and the leaves far overtop it in fig. 3, while in fig. 2 it is almost erect on a slightly curved seta and the leaves reach to its base or only a little beyond it, as in the specimens preserved.

Two other statements in the description contradict each other, and may be verified by the figures and the specimens:

"Caules lineas duas ad quartor alti; pedicellus lineas tres vel quartor emetiens."

The stems are not higher than 5 mm. (4 lines would be 8 mm.) in the specimens, and the pedicels are only 2 mm. long (not 6–8 or 3–4 lines).

BRUCHIA BREVICOLLIS L. & J. Man. 47 (1884).

Bruchia Beyrichiana Sull. Icon. Musc. Suppl. 25, *t. 15* (1874), not Hpe.

In Lesquereux and James' Manual, on page 47, the statement is made that table 15 of Sullivant's Icones Supplement is partly drawn from specimens of *B. brevicollis* L. & J. collected by Ravenel, on the Santee Canal, South Carolina. Hence it became necessary to see Sullivant's specimens. Through the kindness of Dr. Robinson and Mr. Fernald these were sent to me, and I found in the cover all the specimens cited by Sullivant (Icones Suppl. p. 25), including a small portion of the type of *Sporledera Beyrichiana* Hampe, collected by Beyrich, near Baltimore, 1833, and sent to Sullivant by Hampe in 1860. Below the packet Sullivant had written:

"As I supposed, *Sporledera* (*Bruchia*) *Beyrichiana* Hampe is an immature state of *B. brevipes* or *B. flexuosa*. These specimens belong to *B. brevipes*. Schwægrichen's figure is founded on *B. flexuosa*, W. S. S."

This is substantially the opinion he published in the Icones page 24, under *B. brevipes;* later he crossed over these remarks

and wrote on the packet "good species," but the description and plate in the Supplement to the Icones were drawn from Ravenel's specimens, as his herbarium shows. He cites the following synonyms and localities:

Sporledera Beyrichiana Hampe, Linn. **20**: 279 (1837).

Phascum Beyrichianum Schwægr. Suppl. **4**: *t. 301* (1842).

Bruchia Beyrichiana Müll. Bot. Zeit. **5**: 99 (1847).

Hab. first found near Baltimore, by Beyrich; Santee Canal, Ravenel; Burlington, New Jersey, James; North Illinois, Dr. G. Vasey.

All of the specimens above cited, except those collected by Ravenel, are immature, but a careful comparison one with another has enabled me, from leaf characters and imperfect fruiting characters, to say that Sullivant was nearer right in his first opinion than in his last, and that most of the description and all of table fifteen in the Icones Supplement were drawn from the only perfect specimens he had, those collected by Ravenel; hence these must be considered the types of *Bruchia Beyrichiana* Sull. They prove also that *B. Beyrichiana* Sull., is quite distinct from *Sporledera Beyrichiana* Hampe. When compared with Hampe's original, Sullivant's specimens are taller and more densely leafy, the stems quite developed, 2 mm. long, several with the leaves and capsules included reaching 4–5 mm. Hampe's are almost acaulescent, with the leaves crowded at the base, the whole plant not attaining 2 mm. in height. The leaves also show a marked difference; Sullivant's are falcate-secund when dry, erect when moist, with a long slender tip entire below, but distinctly serrate at apex, often 6–8 of equal length, crowded at the apex of the stem; Hampe's are flexuous, recurved and twisted, with a longer, broader base and a stouter point, which when highly magnified shows the short transverse walls to be thickened, giving the back of the leaf the appearance of being papillose, whereas Sullivant's are often perfectly smooth, with the same magnification.

Both have erect pedicels, but Sullivant's are exserted, whereas Hampe's are immersed, and the calyptra in the latter is larger and more lobed. Certainly these two are not the same species.

And as *Sporledera Beyrichiana* Hpe. (Linnæa, **9**: 279,), antedates *Bruchia Beyrichiana* Sull. (Icon. Musc. Suppl. **25**, *t. 15*,

1874) by thirty-seven years, it is the latter which must change its name, and the former must be dropped, as it is a mixed species founded on immature specimens. Fortunately there is a name which unquestionably belongs to *B. Beyrichiania* Sull., for in the description of it in L. & J. Manual, page 47, they say, "Sull. Icon. Musc. Suppl. 25, *t. 15*, partly made upon specimens of the next species."

The next species is *B. brevicollis* L. & J., founded on specimens collected by H. W. Ravenel, Santee Canal, South Carolina; according to their own citation, the very ones cited by Sullivant in the Icones Supplement under *B. Beyrichiana*. A further comparison of the descriptions in both will show that those in the Manual are transcribed from the Icones with a slightly incorrect modification, and a very imperfect characterization for their new species. Omit the words "its top not surpassing the leaves;" change "partly" to "entirely;" combine the two descriptions, omitting all references to *B. Beyrichiana*, and there will remain a good characterization of Ravenel's specimens, with the additional evidence that the spores are large and rough in Ravenel's specimens and are so figured in the Icones, but no mention is made of them in the Manual.

That Sullivant should have drawn table 15 from several specimens is not probable, and contrary to what we know of his careful methods, furthermore the other specimens referred to in the Icones are preserved in the same cover with the above in Sullivant's Herbarium. Those collected by T. P. James, at Burlington, N. J., are immature, but they do not agree with either of the above, when placed side by side under the same cover-glass. They have leafy stems 2 mm. high, but the leaves are subpapillose, and the pedicels stout and recurved with immersed capsules, not sufficiently matured to show the spores. They are probably immature specimens of *B. Sullivanti* Austin. Dr. George Vasey's specimens from Illinois are also immature, so young that they are still acaulescent, the calyptra is only just formed and the capsule is yet a mere thickening of the stout, curved pedicel. The leaves are subpapillose on the back, and specimens preserved in Austin's Herbarinm, labeled "*Bruchia Beyrichiana*, Ringwood, McHenry Co., Ill., collected by Dr. Geo. Vasey," are corrected by Austin to *B. Sullivanti* Aust. It is evi-

dent then that the only specimens in Sullivant's Herbarium from which he could have drawn the figures which were used in the Icones were those collected by Ravenel which Lesquereux and James say are the ones on which they founded *Bruchia brevicollis*.

In order to determime if Ravenel's specimens were sufficiently distinct from the type of *Phascum flexuosum* to maintain *B. brevicollis* as a species, they were placed together and carefully compared.

The best developed specimen of the type is almost an exact counterpart of one of Ravenel's specimens. In both an occasional trace of roughness may be seen on the leaves, although most of them are smooth, slender and subulate; the pedicels are the same in length and position, the capsules smaller, but the proportions of the neck, beak and sporange are the same.

BRUCHIA BEYRICHIANA (Hpe.) Müller.

Sporledera Beyrichiana Hampe, Linnæa, 11: 279 (1837).

Bruchia Beyrichiana Müll. Bot. Zeit. 5: 99 (1847). Sull. Mosses U. S. 17 (1856.)

Phascum Beyrichianum Schwægr. Suppl. 4: *t. 301* (1842).

On page 279 of Linnæa, Hampe says, "Die Capseln sind freilich nicht ausgebildet, aber doch die Form schon zu erkennen." He describes the specimens as follows:

"Muscus flavescens, *Phasco subulato* simillimis, foliis inferioribus ex basi latiore subulatis nervosis, perichætialibus latioribus et longioribus, complicatis integerrimis secundis vel flexuosis. Capsula oblonga erecta-pedunculata, calyptra campanulata eadem includente."

I have not seen Hampe's own specimen of this species, but the one sent to Sullivant by him is too immature to show even the form of the capsule, for that had not begun to be formed, the calyptra and pedicel being still immersed in the leaves. In fact, the plants had only perfected the calyptras, and are still too young to say whether the pedicels would be erect or curved, though there is a slight twist in the seta just below the calyptra. The other characters have been described in the comparison with *B. Beyrichiana* Sull. given above. The following measurements are placed on record as the earlier descriptions are all too indefinite.

Sporledera Beyrichiana Hpe. l. c.

Almost acaulescent, about 2 mm. high, light yellow, with the leaves crowded, sometimes 6–8 of equal length, flexuose, base ½–⅓ the length of the awn, vein broadest where the awn starts, margins sub-serrulate, apex ending in 1–3 larger clearer cells, those of the back of the leaf, subpapillose, by the thickening of the short transverse walls of the cell, seta short, erect, slightly bent at apex, as if becoming arcuate, calyptra large, .075 mm. long, .050 mm. wide, lobes 6–8, not very deep. Capsule and spores not yet formed.

Type locality near Baltimore, Beyrich (1833).

Mr. Anthony Gepp, of South Kensington Museum, sent me copies of drawings from Hampe's specimens made by him and Carl Müller showing that the type is no more developed than the portion of it in Sullivant's Herbarium, hence we shall have to drop *B. Beyrichiana* from the list of North American species, as it is utterly impossible to tell what the character of its capsules or spores might be.

Phascum Beyrichianum Schwægr. Suppl. *t. 301* (1842). The type of this species was sent to us from the Boissier Herbarium and was compared with Hampe's specimens of *Sporledera Beyrichiana*, from Sullivant's Herbarium. I find no record of locality on the sheet other than "Am bor.," though the text says:

"In America boreali D. Schweinitzio lectum, dedit D. Arnott; *Sporlederam* a Beyrichio Baltimoræ lectam E. Hampe habet."

Evidently then they were not the same specimens nor gathered by the same collector, though Schwægrichen gave his the same specific name and referred Hampe's to it as a synonym. When compared the plants are taller than Hampe's 2–3 mm. high, light yellow, with longer more papillose, twisted leaves, with involute margins, channeled vein, curved pedicel, over 1 mm. high; the capsules still immature, but sufficiently developed to show the long neck of a *Bruchia*. (See Figs. 6–7, *t. 301*). Comparing the plants with Plate 301, the figures which are not correct are Fig. 8, which would seem to belong to an *Orthotrichum*, as the young immature capsules of the type are perfectly smooth, and Fig. 5, of the apex of the leaf, which is too broad and blunt as seen with the improved objectives of modern microscopes, and should be figured with a serrulate tip to agree with type specimens.

Therefore it seems likely that these plants are, as Sullivant supposed (Icon. Musc. 24) immature specimens of *B. Sullivanti* Aust. (*B. flexuosa* Sull.), but they might be *B. curviseta* L. J., which also has a flexuose seta, and subpapillose leaves, and without the mature capsule and spores it will be impossible to refer either of these names to *B. Beyrichiana* Müll. as synonyms, for we should be forfeiting a certainty for an uncertainty, therefore it seems best to drop *B. Beyrichiana* from the list of *Bruchias*, especially as its synonymy is already in a sad state of confusion.

2. BRUCHIA SULLIVANTI Austin.

Bruchia Sullivanti Aust. Bull. Torr. Bot. Club, 6: 143 (1877).
Bruchia flexuosa Sull. Icon. Musc. *t. 13* (1864).

Bruchia flexuosa, of Sullivant's Icones, was believed by Austin to be a mixed species, composed of the true *B. flexuosa* and *B. Sullivanti* Austin, to which he referred the plate in the Icones, but not the description.

Bruchia flexuosa Sulliv. Icones (excl. descript.), *t. 13;* Aust. Musc. Appalach, No. 56; haud Schwægr.

"Statura facieque *Br. flexuosæ*, sed inflorescentia paroica foliis subpapillosis, etc., statim dignoscitur."

"Capsule concolorous, the collum much constricted in drying, pale, yellow, becoming fuscous. Spores minute (about $\frac{1}{750}$—$\frac{1}{900}$ of an inch in diameter), yellow, opaque, papillose. Leaves mostly longer than the pedicel (often over-topping the capsule), more or less papillose above (often very obscurely so), nearly or quite entire. Occurs on damp ground, from New England to Florida and Louisiana."

Such is the description given by Austin, and the localities cited below are too general to indicate what he considered the type of his new species, and his Musci Appalachiani (1870) were issued before the publication of this species. Number 56 of his exsiccatæ, however, may be considered to be *B. Sullivanti*, as shown by specimens in his herbarium, from Closter, the locality given for No. 56. These specimens are labeled "*Bruchia flexuosa*," collected in 1862 near Closter," and below is written "*Br. Sullivanti*." (The first quotation marks are his, and evidently refer to his previous naming of the specimens.)

No. 56 in our herbarium was compared with the type from Geneva, and they show the same differences that Sullivant's specimens do, the longer more flexuose seta, more slender capsule,

clearer neck, shorter, more subpapillose leaves. Mixed with Austin's *B. Sullivanti* are specimens which do agree with the type of *Br. flexuosa*, and these are labelled *B. brevicollis* L. & J. Those collected by J. Donnell Smith in Prince Edward County, Va., in 1878, are labelled *B. brevicollis* L. & J., in blue ink, and above Austin has written *B. Sullivanti* var. *brevicollis*, Austin. They differ according to Austin's notes in the plants being "shorter with longer leaves, smooth on the back of the awn, dentate at apex, less canaliculate, with the capsule smaller, shorter beaked, the spores exactly as in *B. Sullivanti*, neck short, opaque. The seta is as often erect and straight as it is bent."

At the foot of the page (BULLETIN, **6**: 143), Austin says:

"The true *Bruchia flexuosa* Schwægr. with autoicous inflorescence and with spores about as in *Br. Sullivanti*, is given in S. & L. Exsic. Ed. 2, n. 41. The specimens were probably collected in Ohio. I have not seen it from any other source."

Austin did not have the type, nor could he have seen it, and he was mistaken in saying "with autoicous inflorescence," for the type, as we have already shown, is paroicous; but the specimens referred to above (No. 41) were examined in our set, compared and drawn side by side with the type, under the camera. The type again has shorter and broader capsule, maintaining the same differences that it does to all the rest of Sullivant's specimens.

And lastly, No. 41 was compared with Austin's 56, and they too both show with a magnification of 300 diameters the same, short, thickened transverse walls on the back of the vein, which gives it the subpapillose appearance.

Bruchia flexuosa Sull. Icon. Musc. 22, *t. 13* (1864).

The specimens found in the cover of *Bruchia flexuosa* sent to me from Sullivant's Herbarium are labelled and numbered as follows:

44. *B. flexuosa*, Texas, Wright, 1845.

60 and 65. *B. flexuosa* Br. & Sch., Lancaster, Ohio, Lesquereux, 1849.

B. flexuosa var. ? Cleveland, Ohio, Dr. Cassell, June, 1856.

B. flexuosa, Columbus, Ohio, Lesquereux, May, 1861.

172. *B. flexuosa*, eight miles below Portsmouth, Va., T. P. James, March, 1867.

173. *B. flexuosa*, near Petersburg, Va., T. P. James, April, 1867.

176. *B. flexuosa* var. *nigricans*? Moyamensing, Philadelphia, Pa., T. P. James, May 30th, 1866.

32. *B. flexuosa* var. *nigricans*. "Spores the same as in the type." Without locality or date, presumably No. 42, S. & L. Musci bor. Am. from Raccoon Mt., Alabama.

There are also three other small packets without locality, date or collector.

Two drawings also are preserved, one of which I cannot satisfactorily match to the specimens. It is labelled "*Bruchia flexuosa*, Hab. Ohio and Southern States, W. S. S., July, 1850," and may have been drawn from one or more specimens.

The other drawing is labelled "*Bruchia flexuosa* var.? Cleveland, Ohio, June, 1856—Dr. Cassell's," the specimens of which are preserved as shown above. These are the ones referred to the variety *nigricans*, in the Mosses of the United States, page 17 (1856), though later in the Icones (1864) he used the drawings made from them to illustrate what he considered the type of the species, though it must be borne in mind that the specimens in Schwægrichen's Herbarium, and not Sullivant's, are the types.

These specimens of Dr. Cassell's, when placed side by side under the same cover with the *type*, show the leaves to be somewhat shorter and broader, *less rough*, the seta also shorter, but the capsule longer and narrower, with a longer beak, and the spores the same in size and roughness. In the original drawing, but omitted from the Icones, the antheridia are indicated in *Figs. 2–3* as naked, in the axils of the leaves below the perichætium, as in *Fig. 13*. *Fig. 4* was added to the Icones, and does not occur in the original drawing. Sullivant has written on the back of the drawing: "I am unable to find any tangible characters to separate these specimens (Cleveland, Dr. Cassell's) from *Bruchia flexuosa*. These specimens are not as slender as usual in *B. flexuosa*, more condensed, pedicel shorter and leaves shorter, etc. The spores .03–.0325–.035 mm. The spores of *B. flexuosa* are the same."

This raises the question as to what specimens Sullivant considered typical; as far as we can learn from his herbarium he had not seen the type specimens. Presumably these would be the specimens which he distributed in 1865 as Number 41 of S. & L.

Musci bor. Am., but without locality. Judging from his herbarium, it must be either the specimens numbered 60 and 65, sent him by Lesquereux, collected at Lancaster, Ohio, in 1849, or those from Columbus, Ohio, May, 1861, also collected and sent to him by Lesquereux; probably the latter, for the second set of these exsiccatæ were put up by Lesquereux, all the duplicate packets bearing his German figures to correspond with the numbers on the tickets. These, too, were compared with the type, and they show the same differences as Dr. Cassell's, even more accentuated. The pedicels are much longer, more exserted and flexuose, the capsules narrower and longer with a longer beak and neck, leaves shorter and more spreading. With the higher powers the walls of the cells on the back of the vein are more thickened than in the type, and the margins are subserrulate. These spores are a little smaller and roughened in the same way as the type. It will be seen, then, that there is not in Sullivant's cover of *B. B. flexuosa* an exact match for the type from Geneva. His specimens all match *B. Sullivanti* Austin, and the specimens in his herbarium which match the types are in the cover of *B. Beyrichiana*, which we have shown he figured in the Supplement to the Icones, plate 15 as that species.

That *B. flexuosa* and *B. Sullivanti* are very closely allied and probably grade into each other is proven by the above comparisons, but that the differences between them are noticeable is shown by the several names which they have given rise to. We think it probable that *B. flexuosa* is a common and variable species, from which *B. Sullivanti* may be separated as of secondary or lower rank.

Bruchia flexuosa var. *nigricans* Sull. Mosses U. S. 17 (1856).

Bruchia nigricans Austin, Bull. Torr. Club, **6**: 143 (1877).

Bruchia Sullivanti var. *nigricans* Lesq. & Jas. Man. 46 (1884).

It should be noted that Sullivant, in the above citation, says: "Whole plant longer; leaves shorter, appressed; spores larger, dark brown. . . . Raccoon Mountains, Alabama, Lesquereux, and 'Cleveland, Ohio, Prof. Cassell.'"

He subsequently figured in the Icones (1864) the last named specimens as the species, as shown above, and referred the specimens from Raccoon Mountains only to the variety. These were

distributed as No. 42 of S. & L. Musci Bor. Am. Ed. 2 (1865), of which there is only one specimen preserved in Sullivant's Herbarium bearing a single capsule. The sterile specimens are much more branching than is usual in the genus. Specimens of No. 42 in our herbarium, two sets in the Jæger Herbarium and those in Prof. Eaton's set have been examined and the spores measured. They vary considerably in size. In our set they are larger, .036–.045 mm., rough, though not spinose, and the outlines of the spores is not very regular. In the Jæger sets I find some spores as small as .027–.029 mm., but with same characteristic surface. These latter have the capsules long-beaked, on a curved seta.

The differences, however, do not seem to be sufficient to separate it as a species, and the remarks by James in the Proc. Am. Acad. **14**: 135, 1879, and in the Manual would seem to account for its variation.

"The variety is evidently due to immersion, as higher upon the dry sand of the borders of the depressions the moss gradually assumes its normal form."

3. BRUCHIA TEXANA Aust. Bull. Torr. Bot. Club, **5**: 21 (1874). ✓

(Plate 213$_4$)

Paroicous, the antheridia naked in the axils of the upper leaves. Plants gregarious, light yellow, varying in size at maturity in the same patch, 3–5 mm. high; stems simple, erect, 2–3 mm. high; leaves smaller at base, crowded around the base of the seta, not reaching the capsule, uppermost 1–1.5 mm. long, broadly clasping at base, contracted into a short subulate awn, composed principally of the thick vein, slightly rough on the back, ending below the serrate apex, narrow and distinct at base; cells of the basal lamina oblong and lax below, becoming irregular, crowded, and serrulate along the awn; seta 1–1.5 m. long, erect, or twisted and recurved, exceeding the leaves; capsule 1.5–2 mm. long, bright orange above, with a long, slender beak; neck large, paler, and contracted when dry, abrupt at base and stomatose, half the length of the capsule, calyptra not reaching the neck; spores yellow, spinosely reticulate, .040–.045 mm., maturing in?

Type locality near Houston, Texas, Hall, also collected by Wright in Texas, 1845, in herb Sullivant under *B. flexuosa* (No. 44). Since collected in South Carolina by Ravenel, and Alabama by Chas. Mohr.

Differing from *B. flexuosa* with which it is mixed in Sullivant's and Austin's Herbaria, in the longer seta, shorter leaves, and larger reticulate spores. The specimens credited to Virginia collected by J. D. Smith in Austin's Musci Appalachiani, Supplement, No. 463, are *B. Drummondii* in Austin's Herbarium. *B. curviseta* L. & J., is very closely allied to this species.

4. Bruchia curviseta L. & J.

Bruchia curviseta L. & J. Man. 47 (1824).

B. Vogesiaca var. 2, Drummond's Southern Mosses, No. 15, in part.

B. Texana Austin, Musci Appach. Suppl. No. 463, in part.

The description in the Manual is good, but the following measurements should be added from Drummond's specimens:

Plants short, 2 mm. high, upper leaves 1 mm. long, often reaching to the summit of the capsules; blunt, dentate or serrate at apex; seta short, .0.5–1 mm. often bent abruptly in two directions; capsules small, 1 mm., neck contracted below the spore-sac when dry; spores spinosely reticulate, .032–.040–.045 mm. the reticulations often .008–.013 mm. in size.

Specimens were distributed by Austin in his Musci Appalachiana as No. 463 as *B. Texana*, collected by Ravenel in South Carolina. It is very close to that species but smaller, and the spores are perhaps slightly more distinctly reticulate than in *B. Texana*.

The type locality is uncertain, as two are given. The label of Drummond's No. 15 reads "Louisiana and New Orleans," and the specimens are mixed with *B. brevifolia* Sull. in Sullivant's set, and with that species and two others, *B. Sullivanti* and *B. Drummondii* (*B. brevipes*) in our set.

Austin also had it from Maryland, collected by J. Donnell Smith, labelled *B. Sullivanti*, "spores too large," and from Prince Edward County, Virginia, also from J. Donnell Smith, and from South Carolina, collected by H. W. Ravenel.

5. Bruchia Donnellii Aust.

Bruchia Donnellii Aust. Bull. Torr. Bot. Club, 6: 144 (1877).

(Plate 214.)

Paroicous, the antheridia naked in the axils of the upper leaves. Plants gregarious in light yellowish green patches, 5 mm. high;

stems erect, 3–4 mm. high, slender, flexuose, leafy to base; leaves curled and recurved, spreading when dry, 1.5–2 mm. long, suddenly contracted into a rough subulate apex, from a broad, hyaline clasping base; lower cells smooth, clear, upper papillose by the thickening of the walls, margins more or less recurved and serrate above; seta exserted, erect or curved, 1.5–2 mm. long, capsules nearly 2 mm. long, orange-colored becoming brown, apiculate, beak straight; neck large, half the length of the capsule, tapering, stomatose; calyptra smooth, lobed; spores .032–.037 mm. papillose, maturing in early spring, from February to April.

Collected at Jacksonville and Rosedale, Florida, by J. Donnell Smith, 1877–1878; also at Gainesville, Florida, by C. E. Faxon, and Aiken, South Carolina, by H. W. Ravenel.

Exsiccatæ: Austin Musci App. Supp. 464.
S. & L. Musci Bor. Am. Ed. 2d, No. 41 in part.

Very nearly allied to *B. Texana* and *B. curviseta*, from which it differs in its papillose not reticulate spores and distinctly papillose leaves.

6. Bruchia Hallii Aust.

(Plate 215.)

Bruchia Hallii Aust. Bull. Torr. Bot. Club, 5: 21 (1874).

Paroicous, the antheridia axillary in the upper leaves. Plants 4–5 mm. high, gregarious in light green patches; stems simple erect, 2–3 mm. high; leaves erect-appressed, the lower short, the upper not longer than 1 mm., all ovate-lanceolate, entire or serrulate, the vein ending in the acute apex; basal cells larger, very lax, upper fusiform or rhomboidal, marginal elongated, occasionally serrulate; perichætial bracts broader, clasping; seta erect or curved, 1–1.5 mm. long, exserted; capsules 1–1.5 mm. long, brown, pyriform, apiculate, beak long, straight, neck tapering, paler than the brown wall of the upper half of the capsule, stomatose; calyptra smooth, lobed, covering only the upper part of the capsule; spores large, .043–.048 mm., papillose, maturing in February.

Type locality not recorded; collected in Texas by E. Hall, February 23, 1876, growing with *Ditrichum pallidum*.

7. Bruchia brevifolia Sull.

Bruchia brevifolia Sull. Moses. U. S., 17 (1856) Icon. Musc. 25, *t. 15* (1864).

In Sullivant's Herbarium are preserved three sets of specimens

as cited by localities in the Icones, and the original drawing of t–15 is also preserved, but it bears no label to indicate from what specimen it was made; it is dated 1857. The specimens issued in Drummond's Southern mosses No. 15, as *Bruchia Vogesiaca* var. 2. Hab. Louisiana and New Orleans, were mixed both in Sullivant's set and ours. Three different species have been separated from it, two new, *B. curviseta* L. & J. Man. 47 (1884), *B. brevifolia* Sull. (1856), and *B. Sullivanti* Austin (*B. flexuosa* Sull.), the last being preserved with *B. brevifolia* in Sullivant's Herbarium, and mixed with it also in our specimen, hence probably the following comparison of Sullivant's. It will be noted that he reiterates the statements made in the Mosses of the United States that the spores are "about the same." This mistake was rectified in the Icones, in tables 13 and 15, Fig. 12, where they differ in one being spinose, the other pitted. In S. and L. Musci Bor. Am. Ed. 2, No. 44, they are young enough to show that four spores are formed in each mother cell.

Bruchia brevifolia (sp. nov. Sulliv).

"Compared with *B. flexuosa*, it is a shorter plant, capsule larger in proportion, more oblong in general outline, not so elliptical, tapering to each end, the operculum shorter, pedical much shorter, not flexuose, scarcely emergent from the perichaetial leaves, which are rigid, erect, connivent, with a much shorter acumination from an oblong more broad obovate sheathing base, the lower stem leaves are triangular, ovate, all with a heavy percurrent costa-reticulation of leaves the same, the spores also about the same, one spore measuring .03 to .03¼ millimeters in diameter. The true *B. flexuosa* is a slender flexuose plant; the *B. brevifolia* is a stiff short stumpy plant.

"*B. brevifolia* is the *B. Vogesiaca* var. 2, No. 15 of Hook, and Wilson in Drummond's Southern Mosses, partly, viz.: the middle specimen in my copy, which see.

"Neither can *B. brevifolia* be considered an immature or young state of *B. flexuosa*, because the capsules and spores are well developed and ripened. *B. flexuosa* preserves its peculiar slender habit in all stages of growth, and in all situations varying, however, a great deal in size; further the two species appear to grow in exactly similar soils.

"*B. brevifolia* is monœcious (see Fig.), the same, however, is the case with *B. flexuosa* notwithstanding Müller Synopsis Musc. says it is dioicous." "W. S. S., July, 1850."

The above comparison would seem to indicate that Sullivant

feared the two might be confused, or found in the same localities, but so far as we know, *B. brevifolia* has only been collected in Texas, South Carolina and Louisiana, the latter being the type locality.

8. Bruchia fusca n. sp.

(Plate 216.)

Autoicous, the antheridia in basal buds; plants gregarious, light yellow or brown, 2–3 mm. high, protonema more or less persistent; stems short, 1–2 mm. long, naked at base, leaves few, three to six, erect-appressed, short, 1 mm. or less, sometimes reaching the base of the capsule, clasping, often broader than long and tricuspidate, entire, or subserrulate with a narrow border of small, retuse cells, apex obtuse, acute or cucullate, vein faint, ending below the apex, or lacking in the lower rudimentary leaves; cells lax at base; seta short, .25–.50 mm. long, immersed or slightly exserted, straight or curved; capsule large and broad, 1–1.5 mm. long, entirely exserted, ovoid-pyriform, suddenly apiculate, neck shorter than, occasionally equalling, the spore-sac, abrupt or tapering to the vaginule; walls of the capsule dense, brown, not transparent, stomata large; calyptra smooth, deeply lobed, half covering the capsule; spores small, .021–.027 mm. brown, angled and pitted, maturing in April.

Growing around quartz pebbles in sandy soil, Maryland, J. Donnell Smith, 1878, also recently collected at the "The Runs, Pine Bluff, North Carolina, April 11, 1891," by Anna H. Searing, M. D., the latter specimens showing the more tapering necks, but agreeing in every other point with those collected by J. D. Smith.

Differing from *B. brevifolia*, to which it had been referred by Austin on account of its short leaves and pitted spores, in the smaller size of the plants, the short, 3-pointed leaves; the vein ceasing below the apex, but more especially in the capsules, which are shorter and broader, brown, not orange-colored, with a shorter neck tapering at the base. From *B. Hallii*, which it resembles in the erect-appressed habit of its leaves, it differs in the shorter seta, longer neck, and the much smaller, pitted spores.

9. Bruchia Drummondii Hpe.

Bruchia Drummondii Hpe. in Sched.; Jæger, Musci Cleist. 36 (1869).

Bruchia brevipes Hook. & Wilson in Drummond's Mosses So. U. S. No. 16 (1841).

Bruchia brevipes Sull. Mosses U. S. 17 (1856); Icon. Musc. 24, *t. 14* (1864), non Hooker.

Plants gregarious, glossy, yellow, 3–4 m. high, stems decumbent and naked at base, densely leafy above; leaves 10–15, uppermost often 3 mm. long, erect or subsecund, abruptly contracted from a broad base, less than one-third the length of the slender tip, vein narrow, not occupying all of the serrate, channeled apex, occasionally serrulate on the back; cells narrow, more lax at base. Autoicous, the antheridia in basal buds; seta short, .25–.50 mm. long; capsule erect, immersed or slightly exserted laterally, one or two in the same perichætium, .75 mm. long, apiculate, upper half bright orange-colored, neck shorter, paler, truncate at base; calyptra smooth, lobate; spores .035–.043 mm., reticulate, maturing in March and April.

Type locality, Louisiana, Drummond, on sandy soil; also collected in South Carolina by Ravenel, and near Petersburg, Virginia, by T. P. James.

Differing from Hooker's type of *Bruchia brevipes*, collected by Harvey at the Cape of Good Hope, Africa, in the larger size of the plants, longer more slender leaves, with the vein not occupying all of the apex, the margins distantly but distinctly serrate, larger capsules, and spores which are reticulate, not spinose.

We have received from Mr. Gepp some sketches and notes from Wilson's Herbarium which show that he realized that a mistake had been made in distributing Drummond's specimens under the same name as Harvey's African ones. The following list of manuscript names shows this:

Bruchia flexuosa var. *γ*.
——— *nana* Wils. mss.
——— *brevipes* H. & W. in Drummd. M. Am.
——— *setacea* Wils. mss.
——— *Drummondii* Wils. mss.

Mr. Gepp notes that the last was used April 7, 1865, and is Wilson's name, though it is the same as the one credited to Hampe in Sched. by Jæger in his Musci Cleistocarpi on page 36 under *B. brevipes*.

Bruchia brevipes Hook. Icon. Plant *t. 231* (1840).

Phascum elegans Hsch. Linnæa **15**: 114 (1841).

The plants from which this species was described were collected at the Cape of Good Hope, by Harvey in July 1837, and

are preserved at Kew in Hooker's Herbarium. In 1841 Hooker and Wilson distributed as "*Bruchia brevipes* Harvey M. S.," No. 16 of Drummond's Southern Mosses, collected in Louisiana, with the remark "Capsulis sessilibus foliis non crispatis." In September of 1892 we received from the Natural History Museum at South Kensington a duplicate set of Drummond's Southern Mosses, on No. 16 of which I find pencilled *B. Drummondii*, Wilson M. S. I learn from Mr. Wright that "No. 16 of Drummond's second collection bears no note in the Kew set, but has been laid in with *Bruchia flexuosa*. In an index to the set in Wilson's handwriting it is referred to thus: "*Bruchia elegans* Hrsch. 16 '*brevipes*' is crossed out with red ink."

Wilson must have been mistaken, however, for *Phascum elegans*, Hsch. Linnæa, 15: 114 (1841) was collected at Newland's Cape of Good Hope by Ecklon, and is cited as the same as Hooker's *B. brevipes* (1840), collected by Harvey, and not our American specimens as will be shown below.

Finding that Sullivant (Icon. Musc. p. 24) had not seen Harvey's specimens, I asked for the privilege of seeing Hooker's type, and have compared it critically with Drummond's 16. This comparison proves that they are closely allied, but sufficiently distinct to warrant their separation. At the first glance the aspect of the plants is different, Drummond's being densely gregarious, bright yellowish green and glossy, Harvey's scattered, and dull dark green; in size also they differ, the American plants being throughout from a third to a half larger than the African ones, as the descriptions will show.

Bruchia brevipes Hooker, Icon. Plant, *t. 231* (1840).

Plants scattered, only 2 mm. high, dull dark green, stems simple, erect, leaves 6–10, lanceolate-subulate, longest 2 mm. entire or faintly appressed serrulate, vein broad occupying all of the thick plane apex, or occasionally channeled, and roughened on the back, narrow at the base. Seta short, .25 mm., capsule erect or inclined, almost entirely exserted, .5 mm. long, apiculate and orange colored above; neck short, not conspicuously truncate. Calyptra small, .33 mm., campanulate, (less beaked and lacerate than figured in (t. 231) spores rough, spinose, opaque, yellow, .037–.040 mm., maturing in July (S. Africa). Collected by Harvey along roadside near Newlands, Cape of Good Hope, with *Phascum nervosum*. A specimen was sent by Dr. Ward to Dr. Torrey labelled *Bruchia Bbrevipes* ? C. B. S., W. W. H.

"*Bruchia Drummondii*, Hpe. in Sched," is one of the synonyms cited by Jæger for "*B. brevipes Hook.*" (Musci Cleist. 36, 1869). He limited this name entirely to the American species, and recognized the African as *B. elegans* (Hsch.) citing "*B. brevipes* Hook. e parte" as one of its synonyms. The American specimens should never be cited as *B. brevipes* Hook., but as *B. brevipes* Hooker and Wilson. Müller in his Synopsis Musc. 1: 18, 1849, cites *B. brevipes* Hook. (*B. elegans* Hsch.) correctly, and limits it exclusively to the African species, as we maintain it should be.

10. Bruchia Ravenelii Wils.

Bruchia Ravenelii Wilson in Sull. Mosses U. S. 17 (1856). Icones Musc. 26, *t. 16* (1864). Austin Bull. Torr. Club, 6: 144 (1877).

In Sullivant's Herbarium are preserved the specimens from which the original description by Sullivant was drawn and the drawings from which the plate in the Icones (Icon. Musc. 26 *t. 16* 1864) was engraved. They are labelled in the handwriting of Lesquereux "*Bruchia Ravenelii* Wils. mss. from Ravenel to Lesquereux," and all the characters but one agree with the drawings and require no explanations. The spores are figured and described as "papillose," but they are more properly reticulate, with confluent ridges, forming a honey-combed surface, which is distinctly hexagonally indented, the ridges appearing on the edges as Sullivant has figured them, but not so on the surface. They are small .027–.032 mm. and it is only with a magnification of 400 diameters that this can be distinctly seen. The stomata too are worthy of description, being slightly immersed, not very distinct, with the surrounding cells radiating and covering the outlines of the guard cells.

Specimens in Austin's Herbarium, sent to him by T. P. James, collected on the Santee Canal by Ravenel, from the same locality as the type, show also the same characters. He also had specimens from Aiken and the seaboard in South Carolina, from Ravenel, and some from Mobile, Alabama, collected by Charles Mohr.

We have received from Mr. Gepp tracings from a drawing of some specimens in Wilson's Herbarium labelled:

B. microcarpa Wils. mss.

B. setifolia Wils. litt. ad. T. P. James, Feb., 1855.

They are undoubtedly this species as shown by the papillose calyptra and the reticulate spores, with the short immersed capsules, the antheridia in a basal bud and the subulate serrulate leaves. These being only manuscript names in Wilson's Herbarium, do not affect the question of the name, but Jæger's published descriptions under the above names are not so easily disposed of.

11. Bruchia Carolinæ Aust.

(Plate 217.)

Bruchia Carolinæ Aust. Bull. Torr. Bot. Club, 6: 144 (1877).

Bruchia Ravenelii Wils., var. *mollis* L. & J. Man. 49 (1884).

Plants gregarious in brown patches, 1 mm., seldom 2 mm. high; stems short, .5–1 mm. high, naked and radiculose at base; leaves crowded at the summit, more or less secund, 1 rarely 2 mm. long, subulate from a broader base; vein channeled, filling the entire or serrulate apex, faintly papillose on the back; basal cells smooth, irregular, upper with thickened walls. Autoicous, the antheridia in brown basal buds. Seta shorter than the capsules, both immersed, or the capsules occasionally exserted laterally, .5–.75 mm. long, pyriform, yellow or brown, conic apiculate; neck large, truncate, stomata immersed, the guard cells covered by the radiating cells around them; calyptra broad, lobed, papillose at apex; spores small, .021–.027 mm., pitted, maturing in February and March.

Type locality, Aiken, South Carolina, H. W. Ravenel, 1872. Exsiccatæ: Austin Musci App. Supp. 461 (1878), also mixed with *B. Drummondii*, in Drummond's Southern Mosses, No. 16 (1841), in our set; also with *B. brevifolia* in S. & L. Musci Bor. Am. Ed. 2, No. 44 (1865).

Differs from *B. Ravenelii* in its pitted spores and smaller size, from *B. brevifolia* and *B. fusca* in its papillose calyptra and subulate leaves, and from *B. brevipes* in its spores and calyptra.

The types of this species are preserved in the herbarium of C. F. Austin at Columbia College. They have been compared with type specimens of *B. Ravenelii* in Sullivant's Herbarium and with Austin's specimens of this species, as well as with No. 43 of Sull. & Lesq. Musci Bor. Am., Ed. II. and Austin's Musci App. No. 460 and his description in the Bulletin. The comparisons which he makes there are conclusive that these two must be held

as distinct species; that is if spore-characters, aside from all others, are of any value in classification, for the spores of *B. Carolinæ* are as distinctly pitted as those of *B. brevifolia* (Sull. Icon. *t. 15, fig. 12*), while those of *B. Ravenelii* are reticulated with crests as described above. Other differences are evident on careful comparison. The plants are smaller, the capsules less immersed, the calyptra less papillose, the beak longer and more conic, the neck longer and clearer and the spores smaller. The leaves are variable in length, sometimes not reaching the base of the capsule, at others far overtopping it, with the seta erect or curved and the capsules protruding laterally or immersed.

Austin says that the inflorescence may be either synœcious or occasionally autoicous. The type specimens and all the others I have examined show the antheridia in small basal buds, easily distinguished by their darker color.

In Sullivant's Herbarium it is mixed with the specimens which he figured for *B. Drummondii*, Hpe. (*B. brevipes* Hook. & Wilson), but we have compared the figures in the Icones (t. 14), and they all seem to have been drawn from the larger specimens.

UNCERTAIN OR REJECTED SPECIES AND VARIETIES.

Bruchia flexuosa var. *minor* C. Müller, Syn. Musc. 1: 20 (1849).

Müller, says in the original description as compared with *B. flexuosa*:

"In partibus omnibus minor, foliis brevioribus strictioribus angustioribus, apice hyalino.

"β. Florida: Schimp. sub nomino *Bruchia brevipedis* Hook. in herb. Hampeano."

Sullivant in the Icones (1864) cites this variety as one of the synonyms of *B. brevipes*, but makes a mistake in the specific name, and in the number (15) of Drummond's exsiccatæ. *B. brevipes* was distributed as No. 16.

Jæger in his Musci Cleistocarpi, p. 36 (1869), cites this variety also as a synonym of *B. brevipes*, and adds *B. Drummondii* Hpe. in Sched., citing the specimens distributed in S. & L. Musci Bor. Am. No. 45, which were issued as *B. brevipes* Hook.

Jæger's Herbarium contained two sets of S. & L. cited above, and another specimen of *B. brevipes* from South Carolina, sent him

by Dr. Döring, which are correctly named. The other two specimens are labelled "*B. brevipes* Sch." One is from Florida, "Ex. herb. C. Müller, 1865;" they are not *B. brevipes*, but seem referable to *B. curviseta* L. & J., and are probably the specimens described as var. *minor* by Müller, as the localities are the same. The other specimen, labelled "*B. brevipes* Sch.," has been corrected in Jæger's handwriting to "*B. flexuosa* C. M. var. *minor*," and these specimens are *B. brevifolia* Sull. They were collected in South Carolina and sent to Jæger by Schimper from the herbarium of Dr. Swartz, 1862.

It will be seen from the original description and this mixture of specimens that we do not yet know what the var. *minor* is, and Dr. Müller is the only one who can tell us. According to the Jæger Herbarium it may antedate either *B. curviseta* L. & J. or *B. brevifolia* Sull., though we are more inclined to think it is the former. According to Jæger's Musci Cleistocarpi, it has priority of 20 years over *B. Drummondii* Hpe., which replaces *B. brevipes* Hook. & Wilson. The original description is absolutely useless in trying to place the specimens, but under the description of *B. flexuosa* he cites Drummond's No. 15, which was distributed as *B. Vogesiaca* var. This specimen in our set contains three species, *B. Drummondii* Hpe., *B. brevifolia* Sull. and *B. curviseta* L. & J.

Bruchia setifolia Jæger.

Sporledera setifolia Wilson (?) in Jæger, Musci Cleist. 35 (1869).

Bruchia setifolia Jæger Adumbratio 1: 224 (1878).

The following is the original description which, as will be shown later, must be credited to Jæger solely, as Wilson is cited with a query, and the specimens and notes in his herbarium, indicate that Jæger was mistaken in crediting this species to him.

7. *S. setifolia* (Wils.) habitu præcedenti similis; foliis e basi angustiore longe setaceis nervo latissimo instructis, toto fere margine erose dentatis, capsula elliptica breviter apiculata, calyptra lævi.

Bruchia setifolia Wilson in Sched.?

Patria. In Louisiana Americæ septentr. collegit cl. *Drummond.*

It will be noted that the description begins by referring to the previous species, which is *B. Ravenelii*, from which this one differs

principally in the smooth calyptra, and the longer, narrower leaves with the margins erose dentate. It does not state whether the seta is short or exserted, but we are to infer that it is the former as in *B. Ravenelii.*

In the Manual on page 46 under *B. flexuosa* we find *Sporledera setifolia* Jæger cited as a synonym of *B. microcarpa* Wils. and Drummond's Musc. Amer. Coll. II., No. 14, and both referred as var. *microcarpa* Wils. to *B. flexuosa*. This is undoubtedly an utter impossibility, as will be seen by comparing Jæger's original descriptions in the Musci Cleistocarpi, as given above. *B. microcarpa* may be, as it is placed next to be *B. flexuosa*, but *B. setifolia*, it is expressly stated, belongs to the acaulescent species, which he grouped under *Sporledera.*

Being curious to learn what connection W. Wilson had with this, though only a manuscript one, I wrote to the authorities at South Kensington, and received the following reply from Mr. Anthony Gepp:

"In answer to your queries about *Bruchia setifolia* and *B. microcarpa* of Wilson, I may say at once that they are identical, and that Jæger is responsible for spreading confusion concerning them. In Wilson's Herbarium there are specimens and drawings marked '*Bruchia microcarpa* Mss. W. W. (*B. setifolia* in litt. ad T. P. James, February 1855), Louisiana, 43.'

"I have made a fresh drawing from typical specimens and enclose a tracing, from which you can draw your own conclusion as to its claim to rank as a species or not. 'Louisiana, 43,' given above are Drummond's locality and collecting number. You now see why T. P. James put *B. setifolia* as a synonym of *B. microcarpa.* Wilson may at one time have referred the plant as a variety to *B. flexuosa*, but at that time he had not broken up *B. flexuosa* in the liberal way that the moderns have done with their better microscopes. You see that the calyptra is rough and the seta short. Jæger's specimen's of *B. setifolia* apear to have been the right plant."

In the Jæger Herbarium there is a specimen labelled "*Bruchia setifolia* Wils. Louisiana, Drummond," without the number of the original set or the name under which it was distributed. These specimens are not very satisfactory, for there are but two cap-

sules, and these had fallen off. No calyptras are preserved, and the seta is so short, or lacking, that only the vaginule remains, so that the capsules appear to have been sessile. The plants are short, less than 3 mm. high, acaulescent, autoicous, the antheridia in basal buds. The leaves are setaceous and secund, 2 mm. long, serrate at apex, smooth on the back or with very slightly protuberant walls. The spores are .032 mm. and distinctly reticulate. The capsules are minute, less than 1 mm. long, ovoid apiculate, with a rounded base and no neck.

We have not been able to place them satisfactorily in any of the species which we now recognize on account of their incomplete state, but we cannot agree with Lesquereux and James in referring them to *B. flexuosa* as a variety, for that species has a distinct stem, and is not autoicous. We think it is more likely to be *B. Drummondii* Hpe. (*B. brevipes* Hook. & Wils.), with which it agrees in being autoicous and acaulescent, and in the reticulate spores, but differs in lacking the short truncate neck, so characteristic of that species. We do not agree with Mr. Gepp in thinking that they are the same as Wilson's specimens, for the description calls for a smooth calyptra and his were rough.

We had thought it possible that it might be *Sporledera palustris*, as that species had a short truncate base to the capsule, without the inflated neck so characteristic of the *Bruchias*, but these specimens are autoicous, whereas *S. palustris* is paroicous and the spores are warty.

BRUCHIA MICROCARPA Wilson in Jæger, Musci Cleist. 37 (1869).

B. flexuosa var. *microcarpa* L. & J. Manual 46 (1884).

The original description given by Jæger, of which the one in the Manual is a translation, reads as follows:

"Gracillima; foliis e basi latiore angustissime subulatis, nervo lato percursis, toto margine obsolete denticulatis, capsula gracile eleganter pyriformi, longius apiculata, apiculo erecto, pedicello elongata, calyptra tenera lævi.

"*Bruchia microcarpa* Wils. in litt.

"*Patria.* In Louisiana clar. Drummond collegit."

The specimens in Jæger's Herbarium are labelled "*Bruchia microcarpa*, Wilson; Louisiana, Drummond," without any number or indication of what they were called in Drummond's Mosses. They have been examined and compared with other species and agree with *B. brevipes*, distributed in Drummond's Mosses as No.

16, but not with the description cited above. The description of the pedicel as elongated would seem to preclude this. The only other species, then, to which this description seems to fit, would be *B. curviseta* L. & J. This species occurs in several sets of Drummond's Mosses under No. 15, from which it was described and is the only one of Drummond's which had not been definitely named, by number, when the Manual was issued in 1884. It agrees with the description in its small capsules, which are pyriform and exserted on a long pedicel, and also long apiculate, with a smooth calyptra. It is very probable that this species will prove to be Wilson's lost species. We cannot be certain of this, however, as the number cited for *B. microcarpa* by Lesquereux and James is No. 14 of Drummond's Southern Mosses. In our set, which was formerly the property of G. J. Lyon, and came to us recently from South Kensington, on No. 14, there is pencilled above the name under which it was distributed "*B. flexuosa* var. *microcarpa*." These specimens have been examined and agree with *B. Sullivanti* Aust. It therefore seems as if *B. microcapa* Wilson would remain uncertain, as we learn from Wilson's Herbarium at South Kensington that his specimens are *B. Ravenelii*. It is probable that Wilson sent Jæger the specimens preserved in his Herbarium, as he credits the species to Wilson "in litt." in which case it would become one of the synonyms of *B. Drummondi*, this name having priority of place in Jæger's Musci Cleistocarpi; but if it should prove to be the same as *B. Sullivanti* or *B. curviseta* it would replace these names, over which it has priority.

Bruchia Hampeana C. Müller, Syn. Musc. 1: 18 (1849).
Sporledera Schwægrichenii Hpe. in litt. fide Müller l. c.
Bruchia Schwægrichenii Jæger, Musci Cleist. 36 (1869).

The description given by Müller refers only to the Chilian specimens sent him by Hampe from Herb. Schwægrichen, and he cites no North American locality for this species. In a postal card dated March, 1893, he says:

"*Br. Hampeana* Chilensis in America septentrionalis non occurrit."

On consulting Jæger's description of *B. Schwægrichenii* I find he cited *B. Hampeana* Müller as a synonym, and besides the original Chilian locality says, "in Louisiana cl. Drummond col-

legit." A comparison of his description of *B. Schwægrichenii* with that of *B. Hampeana* in Lesquereux and James' Manual shows the latter to be a direct translation of the former, and they simply followed Jæger in crediting this species to North America. We have found in the Jæger Herbarium two specimens labelled *B. Hampeana*, collected in Louisiana, one sent to him by Sickenberger, the other by Count Solms. They are both referable to *B. Drummondii* Hpe. (*B. brevipes* Hook. & Wils.), but they are labelled "*B. Hampeana* Sch." This would seem to indicate that there is a name of Schimper's for a North American species which is identical with the name of the Chilian species, but we have not traced this out, it having no bearing on the name. *B. Schwægrichenii*, in Hampe's Herbarium, is also from Chili. It seems evident, then, that Jæger was mistaken in crediting this species to North America. I have not learned whether there are any specimens preserved in the Lesquereux Herbarium of this species, but in a footnote in the Manual they say of the specimens from Louisiana (Drummond) referred to it, that they differ from *B. Ravenelii* "especially in the distinct somewhat long neck of the capsule." It may be that they had specimens of *B. Carolinæ* Austin, which is closely related to *B. Ravenelii*, and differs in this way also. Sullivant says in the Mosses of the United States, page 17 (1856), that *B. Ravenelii* is "very near the Chilian *B. Hampeana* C. Müll."

SPORLEDERA Hampe, Linnæa, 279 (1837).

Char. gen. Theca clausa, calyptra grandis mitræformis vel campanulata integra, "Habitat, propre Baltimore, Americæ Septentrionalis, socie *Phasci subulati*, Schreb. legit. Beyrich, Mai 1833."

This is the description which follows:

Muscus flavescens, *Phasco subulato* simillimis; foliis inferioribus ex basi latiore subulatis nervosis, perichætialibus latioribus et longioribus, complicatis integerrimis secundis vel flexuosis. Capsula oblonga erecta pedunculata, calyptra campulata eam includente.

Then he says: "At first I thought it must be *Phascum flexuosum* of Muhlenberg, but a comparison with Hedwig's specimens in the herbarium of Prof. Schwægrichen, through the kindness of Prof. Kunze, of Leipzig, contradicts this. With *Bruchia*, this Phascaceous moss is not to be united, as it shows an entirely different structure, also it has a multifid calyptra. Our moss has the

structure of *Phascum subulatum*, but is so different in the stalked, elongated capsule, and the campanulate calyptra, that I dedicate it to my friend Herr Sporleder, etc."

It will be seen from the above remarks that Hampe was laboring under a mistake when he contrasted the calyptras of *B. flexuosa* with his *Sporledera Beyrichiana*, due to the fact that there is a a mixture in Schwægrichen's Supplement, in the figure of the calyptra of *Phascum flexuosum*. Furthermore, a part of the type specimen from Hampe's Herbarium is preserved in Sullivant's Herbarium, and although they are immature, yet there is no doubt that it is a species of *Bruchia*, closely allied to the type species of the genus *B. flexuosa*, which antedates *S. Beyrichiana* by fourteen years.

The other species, *B. palustris* (Br. & Sch.) C. Müll., which, according to Müller (Syn. Musc. 1: 19, 1848), was admitted to this genus by Hampe (in litt.), and is so maintained by Limpricht (Rab. Kryptfl. 4: 204), must either be given a new generic name, or merged into *Bruchia*. The absence of the characteristic neck of *Bruchia* would seem to justify its generic rank; the lobate calyptra throws it out of *Pleuridium*, where Schimper placed it, though it is more liable to be mistaken for *P. subulatum* than for any species of *Bruchia*.

The original description of *Sporledera*, calling as it does, for a "large" calyptra, enclosing the capsule, makes it doubtful whether *Phascum palustre* can be included in this genus. Furthermore, it is a question whether a genus can be maintained for a species subsequently referred to it, when the original species and characters of the genus are referable to an older genus.

Notes on some Exoasceæ of the United States.*

By George F. Atkinson.

Material has accumulated from several years collecting which led me to begin the preparation of a paper on the prunicolous species of the *Exoasceæ* of the United States. Unexpectedly a

* I wish to acknowledge my indebtedness to Prof. Thomas Meehan, Prof. L. H. Pammel, Mr. J. B. Ellis, Prof. A. B. Seymour and Mrs. Flora W. Patterson, for favors mostly in the communication of material of some of the prunicolous species.

number of new species came to light when the critical study was made. This paper, which is now in press, will present numerous illustrations both of the deformities caused by these fungi in their hosts and of the structure of the various species of the parasites. It has seemed advisable to present in the BULLETIN some notes on these species, with descriptions of those which are considered new. I anticipate there will be some criticism of the disposition which I have made of certain forms, and I beg those who feel thus disposed to withhold a final judgment until the illustrated paper shall appear. There will be given a fuller discussion of the grounds for this arrangement, as well as careful camera lucida drawings, all to the same scale, so that a better defense of my position will then appear than could possibly be given in these notes.

EXOASCUS DEFORMANS (Berk.) Fuckel.

In the arrangement which I have proposed of the forms occurring on leaves this species occurs only on the leaves and shoots of the peach, *Amygdalus Persica*.

EXOASCUS PRUNI Fuckel.

Exoascus Pruni, as I understand it from the material at hand, occurs only on the fruit of *Prunus domestica* L. in the United States.

EXOASCUS INSITITIÆ Sadebeck.

To this species I would refer the specimens collected by Seymour at Temple, N. H., June 16, 1888, on the leaves of *Prunus Pennsylvanica* L. See Seymour and Earle, Economic Fungi, no. 15. The specimens to which I have had access show several small twigs curved to one side growing from the end of a larger one. The twig has very much the appearance of a small "Witches' Broom." The young twigs are pale and slender, the leaves slightly and finely folded or wrinkled, and the under surface is greyish-white in color from the asci. These characters, together with the size of the asci and the relative size of the asci and stalk-cells agree, it seems to me, with Sadebeck's* species as he describes it on *Prunus insititia* L. and *P. domestica* L.

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*Unters. u. d. Pilzgattung *Exoascus*, etc. Ab. a. d. Jahrb. d. Hamb. Wiss. Anst., 113. 1884.

Kritische Unters. u. d. durch *Taphrina*-Arten, etc. Ibid, 8: 27. 1891.

Die parasiten Exoasceen. Ibid, 10: 2, 48. 1893.

EXOASCUS CERASI (Fuckel) Sadebeck.

To this species I refer the specimens collected at Germantown, Pa., on "escaped cherry trees," by Prof. Meehan, and distributed as *Exoascus Wiesneri* Rathay, in Ellis' N. A. F. no. 2286. It forms "Witches' Brooms" and agrees in all essential characters with Sadebeck's characterization of this species which occurs on *Prunus Avium* L. and *P. Cerasus* L. in Europe. Prof. Meehan writes me that the cherry trees from which the specimens were gathered are *P. Avium* L.

EXOASCUS COMMUNIS Sadebeck.

This occurs on the fruit of *Prunus maritima* Wang., forming "pockets" (Dartmouth, Mass.), *P. pumila* L., *P. nigra* Aiton (Alma, Mich.), and *P. Americana* Marshall (Seymour and Earle, Economic Fungi, no. 13, Madison, Wis.). It differs slightly from *E. Pruni* Fuckel, the asci being quite regularly clavate and the stalk-cells proportionately more slender, pointed below, and according to Sadebeck (l. c.) they do not intrude between the cells of the epidermis.

EXOASCUS FARLOWII Sadebeck.

This deforms the fruit and floral envelopes of *Prunus serotina* L. According to Sadebeck (l. c.), the asci are not crowded but separated from each other. In the examination of a large amount of material from different parts of the United States, I have rarely found this to be the case. There are, however, other characters mentioned by Sadebeck which make it a good species.

EXOASCUS CONFUSUS n. sp.

This name I have proposed for the species which deforms the fruit and floral envelopes of *Prunus Virginiana* L. A study of the structure of the fungus has convinced me that it is specifically distinct from *E. Pruni* on *P. domestica*. The asci on the fruit of *P. domestica* I have found, in the specimens examined, constantly more slender, and the stalk-cells also more slender proportionately than those on the fruit of *P. Virginiana*. These are 30–45 μ long by 8–12 μ in diameter. The stalk-cells are 15–30 μ long by 6–10 μ in diameter; they are nearly or quite the same diameter as the asci and are proportionately longer than those of *E. Pruni* on *P. domestica*. The proportion between these

two structures is more nearly the same as that existing in the case of the *E. Farlowii* Sadeb. on *P. serotina*, while the asci and stalk-cells of *E. Pruni* Fuckel on *P. domestica* are more nearly related to those of *Exoascus communis* Sadeb. on *P. maritima, pumila, nigra*, etc. This is what we would naturally expect since *P. Virginiana* and *P. serotina* belong to a different section of the genus *Prunus* than do *P. domestica*, etc. The physiological influence of the fungus on the fruit of *P. Virginiana* is also different from that of *E. Pruni* on *P. domestica*. The floral envelopes are constantly subject to hypertrophy and also bear asci, in which respect it also agrees with that on *P. serotina* and differs from that on *P. domestica*.

EXOASCUS LONGIPES n. sp.

This species has been found at Danby, near Ithaca, N. Y., producing "pockets" in the fruit of *Prunus Americana* Marshall. It is related to the *E. Pruni* and *E. communis* types, but differs in the long stalk-cells which are strongly intruded between the cells of the epidermis. The asci are 30–40 μ long and 7–10 μ in diameter. The stalk-cells are 25–35 μ high by 3–5 μ in diameter, being usually much narrower below. The lower ends of the cells of the hymenium begin quite early to intrude themselves between the epidermal cells.

EXOASCUS DECIPIENS n. sp.

This has been collected at Ætna and Danby, N. Y., on the leaves of *Prunus Americana* Marshall. It sometimes produces isolated, open, shallow pockets in the leaves, but more frequently attacks a large part of the bases of expanded leaves, where it throws the leaf into a series of fine, irregular folds. On the lower side of the leaf the asci are scattered or rather loosely aggregated in groups. The asci are 20–40 μ long by 7–10 μ in diameter. The stalk-cells are 6–13 μ high by 7–12 μ in diameter, and are usually rounded below. The spores are oval or broadly elliptical, and 3–4 μ in diameter. Conidia are frequently developed, while still in the ascus, by budding.

The shoots are also attacked, and sometimes enlarged, though I never have seen the asci on them. Sometimes the young leaves are attacked and killed without the development of any asci and

become black and crisp, and the bases of the larger leaves which bore the asci also become blackened. This also extends into the ends of the affected shoots.

EXOASCUS DECIPIENS SUPERFICIALIS n. var.

The half developed fruits of *Prunus Americana* Marshall are sometimes affected on the surface with a species of *Exoascus* which may prove to be a distinct one, but for the present it seems best to place it as a variety of this species, especially since the specimens were found on one of the same trees, though not in close proximity to the affected leaves. While the mycelium is found rather scantily to some depth in the tissues of the fruit, the stone appears to be normally developed, or at least not absent. The asci are 25–30 μ long by 8–11 μ in diameter, and the stalk cells are very short. Farther study is necessary to determine the limits of the characters.

EXOASCUS MIRABILIS n. sp.

The distorted young buds and shoots of *Prunus angustifolia* Marshall, the Chickasaw plum (*P. Chicasa* Michx.), I have used as the type of this species. It occurs in the Southern States and some of the Western. I have observed it for three years (1890–92) in Alabama (and in S. C. in 1889),* where it sometimes produces serious injury both to wild and cultivated varieties. The buds become transformed into a large clavate or ovate mass of tissues, which is usually hollow within and much resembles the tissues of the plum "pockets," caused by *E. Pruni*. The surface of these hypertrophied buds is covered with the asci. The asci are slightly clavate, rounded or truncate at the free ends, are 25–45 μ long by 8–10 μ in diameter. The stalk-cells are 10–18 μ high by 5–8 μ in diameter, are usually rounded or truncate at the base, and do not intrude between the cells of the epidermis. The spores are quite regularly elliptical. To this species I also would refer specimens from Iowa, communicated by Prof. Pammel, on the buds of *Prunus hortulana* L. H. Bailey, a closely related species, and upon *P. Americana* from the same place.

EXOASCUS MIRABILIS TORTILIS n. var.

On the fruits of the Chickasaw plum, *P. angustifolia* Marshall,

* Erwin Smith reports it from Maryland and Georgia, Journ. Myc. 6: 108.

in the Southern States, the fruit is frequently distorted by a fungus which I take to be of the same species as the one on the buds. All the essential characters are the same, but the asci and stalk-cells seem to be on the average a little longer, probably due to the greater amount of nourishment which the fruit provides. In the specimens examined the entire fruit is not affected as in the case of *E. Pruni* and related species, but only one side, sometimes only a small portion of it. Only one side then is hypertrophied and may appear as a large wart, or the fruit may be curved and variously twisted. Rarely does it form a "pocket." In order to avoid possible confusion, I have thought it well to distinguish this fruticolous form as a variety.

The fruits of cultivated varieties of *P. Americana*, in Iowa, appear to be somewhat similarly distorted, and with the examination I have made, they, as well as the asci, etc., seem to be more nearly related to this form than to *E. communis* Sadebeck, but I should prefer to reserve a decision until further observation is at hand as to the relation of these fruits to the deformed buds of *P. Americana*.

EXOASCUS RHIZIPES n. sp.

This interesting species I have found upon the Japan plum, *Prunus triflora* Roxburgh. I collected it at Auburn, Ala., in May, 1892. It deforms the buds and fruit very much as *E. mirabilis* Atkinson, does those of *P. angustifolia*, but the structure of the fungus is quite different. It is more closely related to the *E. longipes* Atkinson on the fruit of *P. Americana* Marshall. From this it differs in the still longer stalk-cells which intrude farther between the cells of the epidermis, and especially in the possession of numerous rhizoids which grow not only from the stalk-cells, but also from the lower portion of the asci. The form of the plant on the fruit I have used as the type of the species. Here the asci are 30–40 μ long by 8–10 μ in diameter. The stalk-cells are 25–40 μ long and 3–5 μ in diameter, tapering much below. In very thin sections the lower part of the hymenium, from the numerous rhizoids which branch off at all depths, appears as a cellular tissue from which the asci arise.

The form on the bud is similar, but the rhizoids are not as long nor as numerous, but still much more so than in *E. longipes*. These

characters with the different physiological effect produced on the host seperate it from that species.

EXOASCUS VARIUS n. sp.

As the type of this species I have used the *Exoascus* on the leaves of *Prunus serotina* L., which I have collected very abundantly in Alabama. It is usually referred to *E. deformans*. It appears to me to be clearly distinct from that species, and to approach nearer in the relative proportion of the stalk-cells and asci to the species on the fruit of *P. serotina*, viz. *E. Farlowii* Sadeb. The asci are 20–27 μ long by 8–10 μ in diameter, and the stalk-cells 12–17 μ high by 8–10 μ in diameter. These measurements are taken from specimens which represent the longest stalk-cells. There are great variations and frequently the stalk-cells are only one-fourth as long as the entire fruit body, instead of one-third as long. The asci occur on both sides of the leaves.

The fungus quite frequently deforms the same shoots on which the affected leaves are borne, but there is no tendency, so far as I have observed, to form "Witches' Brooms." Specimens of this were distributed by Seymour and Earle, Economic Fungi, no. 128, as *Taphrina deformans* (B.) Tul. What I take to be the same was distributed in Ellis' N. A. F. no. 2285 b. as *Taphrina Prunı* (Fuckel), from Missouri. I have specimens from Smyrna, Del., communicated by Ellis, and it occurs in other places.

Rather scanty specimens on the leaves of *Prunus demissa* Walp. from Ute Pass, Colorado, ex herb. Trelease, communicated by Prof. Pammel, I have referred to this species with some doubt.

EXOASCUS CECIDOMOPHILUS n. sp.

This is another very interesting species which I collected near Ætna, N. Y., July 6, 1894, and other places. It occurs on galls formed by the larvæ of some cecidomid on the fruit of *Prunus Virginiana* L. The greater part of the hypertrophy is controlled by the larvæ of the cecidomid. The fungus is mostly superficial, the mycelium being scanty and not penetrating very deep. The deformed fruits are two to four times longer than the normal ones and slightly broader. The ends are rounded, the middle a little inflated, a slight strong constriction near the base which appears to flare out, and in doing so, gradually appears to break away

from the receptacle at one or more points and thus opens the gall. The tissue of the gall is quite hard as compared with that of the hypertrophied fruits caused by *E. Pruni* and related species. The hollow interior is comparatively smooth, and in the apex of this several of the larvæ of the cecidomid are bunched.

The fungus appears only to attack a portion of the surface. These portions are then still more swollen and cause the gall to be quite strongly curved. The asci are cylindrical or rarely clavate. They are 30–40 μ long by 6–10 μ in diameter. The stalk-cells are very broad and rounded below, being 6–10 μ high by 10–15 μ in diameter.

Further study is needed to determine just the relation which the cecidomid bears to the fungus. At the present writing I do not think that the fungus occurs on all of the fruits which are deformed by the insect.

Besides these prunicolous species of Exoasceæ two others worthy of note have been collected by myself in the Southern States. One of these proves to be undescribed.

EXOASCUS AUSTRALIS n. sp.

This was collected at Auburn, Ala., April 30, 1892, on the leaves of *Carpinus Americana* Michx. It attacks only the leaves and does not deform "Witches' Brooms," as does *Exoascus Carpini* Rostrup, upon *Carpinus Betulus* in Europe. It is in other respects very different.

Usually nearly the entire leaf is affected and strongly arched upward, giving it a rude, boat-shaped appearance. There are also separate archings between the larger lateral veins which thus throw the surface into a series of strong folds. The upper surface of the leaf is bright red until it begins to die, when it turns brown, then black, then falls away.

The asci are borne only upon the upper surface, in so far as I have observed. They stand closely crowded together They are mostly cylindrical, and 50 μ long, but sometimes vary from 30–60 μ long. The usual diameter is from 7–8 μ, but sometimes they become even 10 μ, where they are not very much crowded. The ends are truncate. They lack a stalk-cell, but frequently the base is more or less abruptly narrowed into a

short stalk-like base. The spores are round and measure 4–5 μ in diameter. The mycelium is subcuticular only, not penetrating into the tissues of the leaf.

TAPHRINA AUREA (Persoon) Fries.

This species was collected at Columbia, S. C., May, 1889, on the leaves of *Populus monilifera* Aiton. It forms rounded, rather deep, open pockets which arch upwards, the asci being on the concave or under side of the spots. The asci are of the slender kind in the specimens examined, with long narrow stalk-cells. which penetrate far between the epidermal cells. According to Sadebeck this species has hitherto been reported on *P. monilifera* only from Denmark. It is also, I believe, the first recorded occurrence of this species in North America, the specimens which have been heretofore reported as belonging to this species in this country occur on the fertile aments of species of *Populus*, which is entirely different. These specimens on the fertile aments of several species of *Populus* (*tremuloides*, *Fremontii*, *grandidentata*), have been referred by Farlow to *Taphrina rhizophora* Johanson. I have had an opportunity of examining specimens from the fertile aments of *Populus tremuloides* Michx. collected at Ithaca, N. Y., by R. H. Pettit, May 13, 1891. They are certainly *Taphrina rhizophora* Johanson, the asci lacking the stalk-cells, and the narrowed base penetrating 30–40 μ in the tissue of the hypertrophied ovary.

Botanical Notes.

The Systematic Botany of North America has been inaugurated by the distribution of sample pages taken from the manuscript of the Hepaticæ, prepared by Professor Underwood. The board of editors announce the following parts for 1895, but their sequence may be somewhat changed:

Vol. 5: Parts 1 and 2, Pyrenomycetes by Messrs. J. B. Ellis and B. M. Everhart; Vol. 9: Part 1, Hepaticæ by Prof. L. M. Underwood; Vol. 10: Part 1, Typhaceæ, Sparganiaceæ, Naiadaceæ, Juncaginaceæ, Alismaceæ, Hydrocharitaceæ by the late Dr. Thomas Morong; Vol. 11: Parts 1 and 2, Cyperacæ by Prof. N. L. Britton and Prof. L. H. Bailey.

Index to Recent Literature relating to American Botany.

Bescherelle, E. Musci Centrali-Americanæ in Guatemala, Costa Rica, Columbia et Ecuador a cl. F. Lehmann lectæ. Bull. Herb. Boiss. **2**: 389–400. Je. 1894.

New species are described in the genera *Holomitrium*, *Fissidens*, *Peromnion*, *Brachymenium*, *Prionodon*, *Porotrichum*, *Lepidopilum*, *Microthamnium* and *Hypopterygium*.

Bessey, C. E. Evolution and Classification. Proc. Am. Assoc. Adv. Sci. **42**: 237–351. Reprint issued 6 Jl: 1894.

Vice-presidential address before Section G, at Madison, Wis. 17 Ag. 1893.

Bloomfield, L. M. Contributions to the Life History of the Wheat Plant (*Triticum vulgare*). Ann. Rep. Ohio State Acad. Sci. **2**, 12–14. 1894.

Brandegee, Katharine. Studies in *Ceanothus*. Proc. Cal. Acad. Sci. (II.) **4**: 173–222. 2 Je. 1894.

Briquet, John. Rectifications de Nomenclature. Bull. Herb. Boiss. **2**: 439, 440. Je. 1894.

Accepts the genus *Ramona* Greene as prior to *Audibertiella* Briquet, and transfers to it all the species of *Audibertia* Benth.

Brotherus, V. F. Musci Schenckiana. Hedw. **33**: 127–136. 20 Je. 1894.

Contribution to the Moss-flora of Brazil.

Clarke, Henry L. The Meaning of Tree-Life. Am. Nat. **28**: 572–589. 1894.

Claypole, E. W. Cryptogamic Flora of Summit County. Am. Rep. Ohio State Acad. Sci. **2**, 40. 1894.

List of species without localities.

Claypole, E. W. Grasses of Summit County, Ohio. Ann. Rep. Ohio State Acad. Sci. **2**, 46. 1894.

Clements, Frederick E. A preliminary List of the Botanical Expeditions in Nebraska, 1803–1893. Bot. Surv. Neb. **3**, 39–42. 18 Je. 1894.

Clendenin, Ida. *Synchytrium* on *Stellaria media*. Bot. Gaz. **19**: 296, 297, *pl. 28*. 16 Jl. 1894.

Clos, D. Du demembrement du genre *Hypericum* et d'une singulaire méprise afférente a *l'Heiodes* d'Adanson. Bull. Soc. Bot. Fr. **41**: 290–301. Je. 1894.

Coulter, John M. A Manual of the Phanerogams and Pteridophytes of Western Texas. Contr. U. S. Nat. Herb. **2**: pp. 588. 1892–1894.

A descriptive flora of the region, the Juncaceæ by F. V. Coville, *Carex* by L. H. Bailey, Gramineæ by L. H. Dewey, and Pteridophyta by L. M. Underwood.

Cunningham, K. M. Studies in the Biology of the Diatoms. Am. Mo. Mic. Journ. **7**: 193–208. 1894.

Davy, J. Burtt. Contribution to the History of *Achyrodes aureum*. Erythea, **2**: 113–119. Jl. 1894.

Foltz, K. O. The phanerogamic Flora of Summit County. Ann. Rep. Ohio State Acad. Sci. **2**, 21–31. 1894.

A list of species without localities.

Goff, E. S. Noxious Weeds. Bull. Wis. Exp. Sta. 39, pp. 40, *pl. 13*. Ap. 1894.

Gives weed law and discusses in particular the Russian thistle (*Salsola Kali Tragus*).

Greene, Edward L. Novitates occidentales—VII. Erythea, **2**: 119–122. Jl. 1894.

Describes *Lupinus fallax*, *L. Michenerii*, *Delphinium Emiliæ*, *Eschscholtzia cucullata*, *Hemitomes pumilum*, *Stachys velutina* and *S. stricta*.

Heald, F. D. Noteworthy anatomical and physiological Researches. Bot. Gaz. **19**: 284–295. 16 Jl. 1894.

The fixation of free nitrogen by plants.

Hooker, J. D. *Houlletia Landsbergi*. Curtis' Bot. Mag. *pl. 7362*. Jl. 1894.

A Costa Rican orchid.

Kellerman, W. A. Notes on drying botanical Specimens. Ann. Rep. Ohio State Acad. Sci. **2**, 37–38. 1894.

Kellerman, Mrs. W. A. The Evolution of Indian Corn. Ann. Rep. Ohio State Acad. Sci. **2**, 32–33. 1894.

Macdougal, D. T. Experimental Plant Physiology, by Dr. Walter Oels. [Translation] 8vo. pp. 86, Minneapolis. 1894.

McClatchie, A. J. Additions to the Flora of Los Angeles County and Catalina Island. Erythea, **2**: 122–125. Jl. 1894.

Masters, Maxwell T. The Cypresses of Monterey. Gard. & For. **7**: 298. 25 Jl. 1894.

Note on *Cypressus macrocarpa*, its distribution and close alliance to *C. Guadeloupensis*.

Meigen, Fr. Biologische Beobachtungen aus der Flora Santiagos in Chile. Trockenschutzeinrichtungen. Engler's Bot. Jahrb. **18**: 394–480. 1894.

Miller, S. A. The petrified Forest of Arizona. Journ. Cincin. Soc. Nat. Hist. **17**: 56–58. Ap. 1894.

Peirce, George J. A Contribution to the Physiology of the Genus *Cuscuta*. Ann. Bot. **8**: 53–118, *pl. 8*. Mr. 1894.

Pound, Roscoe. Bibliography of the Flora of Nebraska. Bot. Surv. Neb. 3, 43–48. 18 Je. 1894.

Reed, Minnie. A peculiar Malformation of an Ovary and Placenta in *Begonia rubra-grandiflora*. Bot. Gaz. **19**: 298. 16 Jl. 1894.

Rusby, H. H. Observations of a Pharmacognocist in England. Pamph. pp. 12. 1894.

Rydberg, P. A. A Revision of the Nomenclature of the Nebraska Polypetalæ. Bot. Surv. Neb. 3, 20–39. 18 Je. 1894.

Sargent, C. S., Editor. North American Thorns. Gard. & For. **7**: 292, *f. 49*. 25 Jl. 1894.
Notes on several species of *Cratægus* and illustration of *C. Crus-galli*.

Sargent, C. S., Editor. *Phlox divaricata*. Gard. & For. **7**: 255, *f. 43*. 27 Je. 1894.

Sargent, C. S., Editor. *Passiflora manicata*. Gard. & For. **7**: 264, *f. 44, 45*. 4 Jl. 1894.

Sargent, C. S., Editor. The Tupelo, *Nyssa sylvatica*. Gard. & For. **7**: 273, *f. 46*. 11 Jl. 1894.

Schiffner, Dr. Victor. Revision der Gattungen *Bryopteris*, *Thysanthus*, *Ptychanthus* und *Phragmicoma* im Herbarium des Berliner Museums. Hedw. **33**: 170–176. 20 Je. 1894.

Selby, A. D. Notes on Erysipheæ. Ann. Rep. Ohio State Acad. Sci. 2, 36–37. 1894.
Record of *Microsphæra Euphorbiæ* and *M. Russellii* at Columbus.

Selby, A. D. Progress in the Study of the Fungus of the Wheat Scab. Ann. Rep. Ohio State Acad. Sci. 2, 33–34. 1894.

Shaw, Walter R. *Pleodorina*, a new Genus of Volvocineæ. Bot. Gaz. **19**: 279–283, *pl. 27*. 16 Jl. 1894.
Describes genus and one species, *P. Californica*.

Smith, Erwin F. Peach Yellows and Peach Rosette. U. S. Dept. Agric., Farmers' Bull. 17, pp. 20, *7 figs*. 1894.

Smith, John Donnell. Undescribed Plants from Guatemala and other Central American Republics.—XIII. Bot. Gaz. **19**: 255–266, *pl. 24–26*. 16 Jl. 1894.

Stephani, F. Hepaticæ Centrali-Americanæ in Guatemala, Costa Rica, Columbia and Ecuador a cl. F. Lehmann lectæ. Bull. Herb. Boiss. **2**: 402, 403. Je. 1894.

Stephani, F. Hepaticarum species novæ—VI. Hedw. **33**: 137–169. 20 Je. 1894.
The genus *Frullania*

Underwood, Lucien M. Notes on our Hepaticæ.—II. Bot. Gaz. **19**: 273–278. 16 Jl. 1894.
The genus *Riccia*. Gives descriptions of all the old species and three new ones—*Riccia aggregata*, *R. Catalina* and *R. Brandegei*, with geographic distribution and key.

Voorhees, E. B. Crimson or Scarlet Clover, its Growth, Composition and Usefulness. Bull. N. J. Exp. Sta. 100, pp. 32, *pl. 2*. 1894.

Warnstorf, C. Sphagnaceæ Centrali-Americanæ in Guatemala, Costa Rica, Columbia and Eucador a cl. F. Lehmann lectæ. Bull. Herb. Boiss. **2**: 400, 401. Je. 1894.
S. Costa-Ricense described as new.

Webster, F. M. Same Notes on Entomophthoreæ. Ann. Rep. Ohio State Acad. Sci. **2**, 31–32. 1894.
Record of observations on species of *Empusa*.

Werner, W. C. New Phænogams for the Ohio Flora. Ann. Rep. Ohio State Acad. Sci. **2**, 38–39. 1894.
Record of 27 species and varieties, with localities.

Contributions from the Herbarium of Columbia College.

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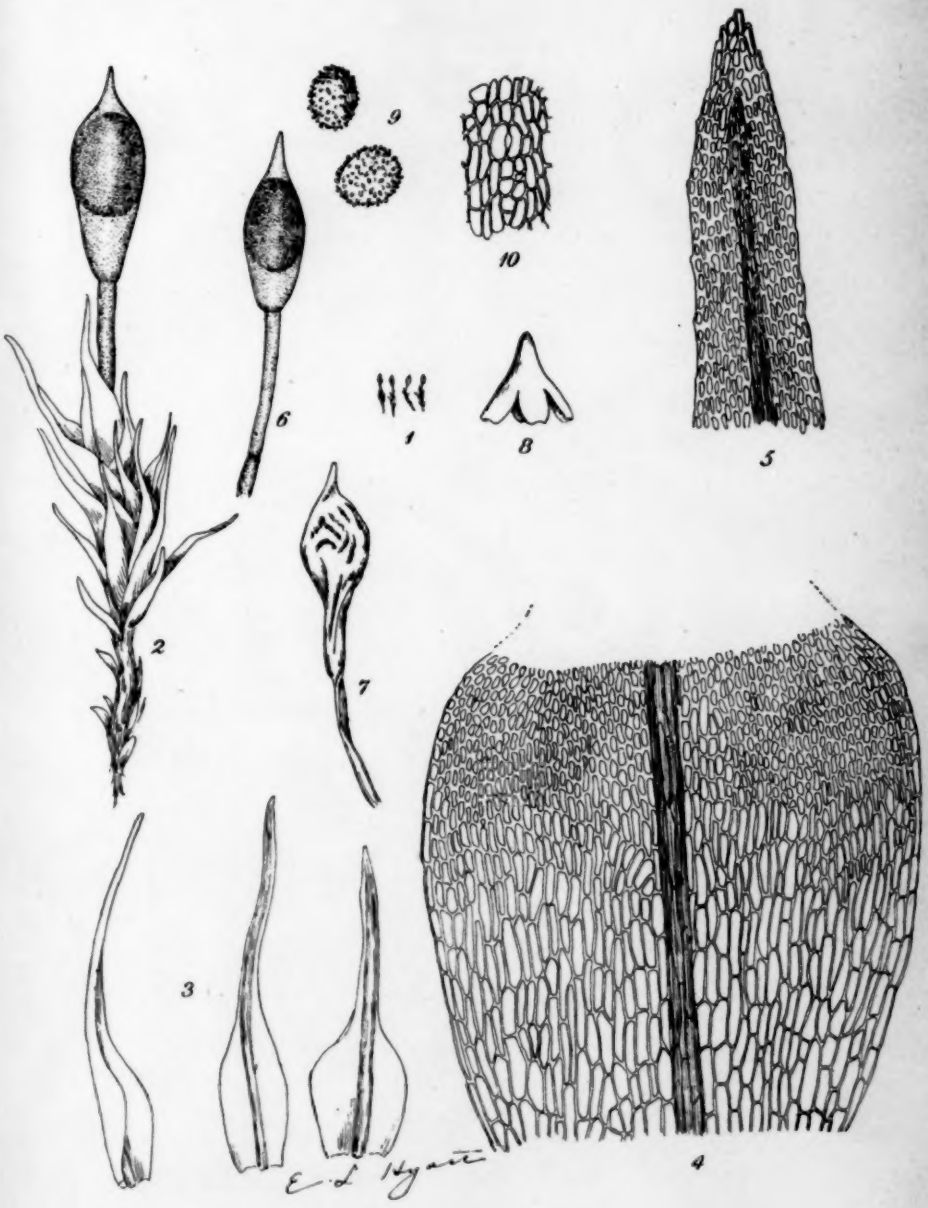

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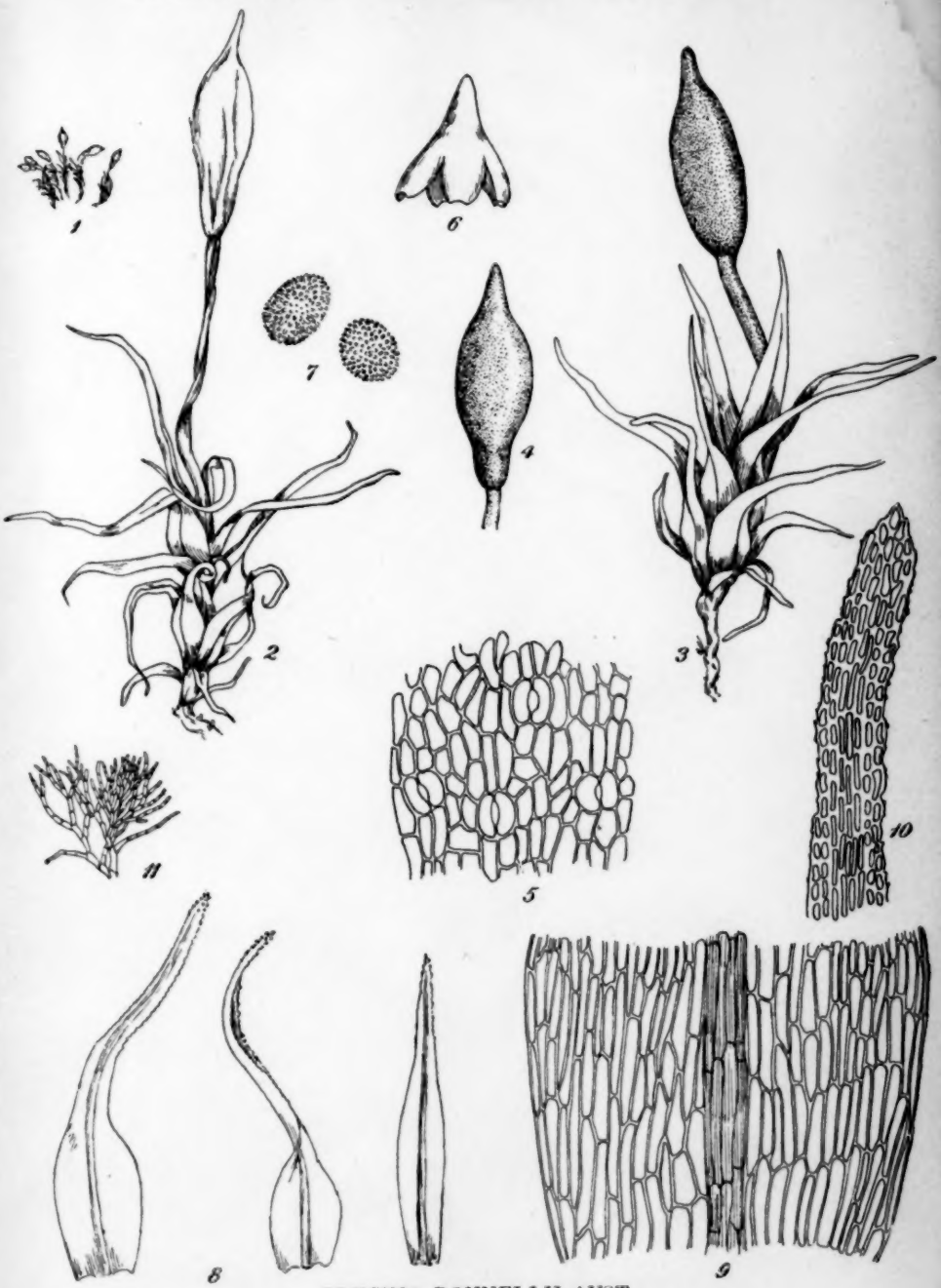

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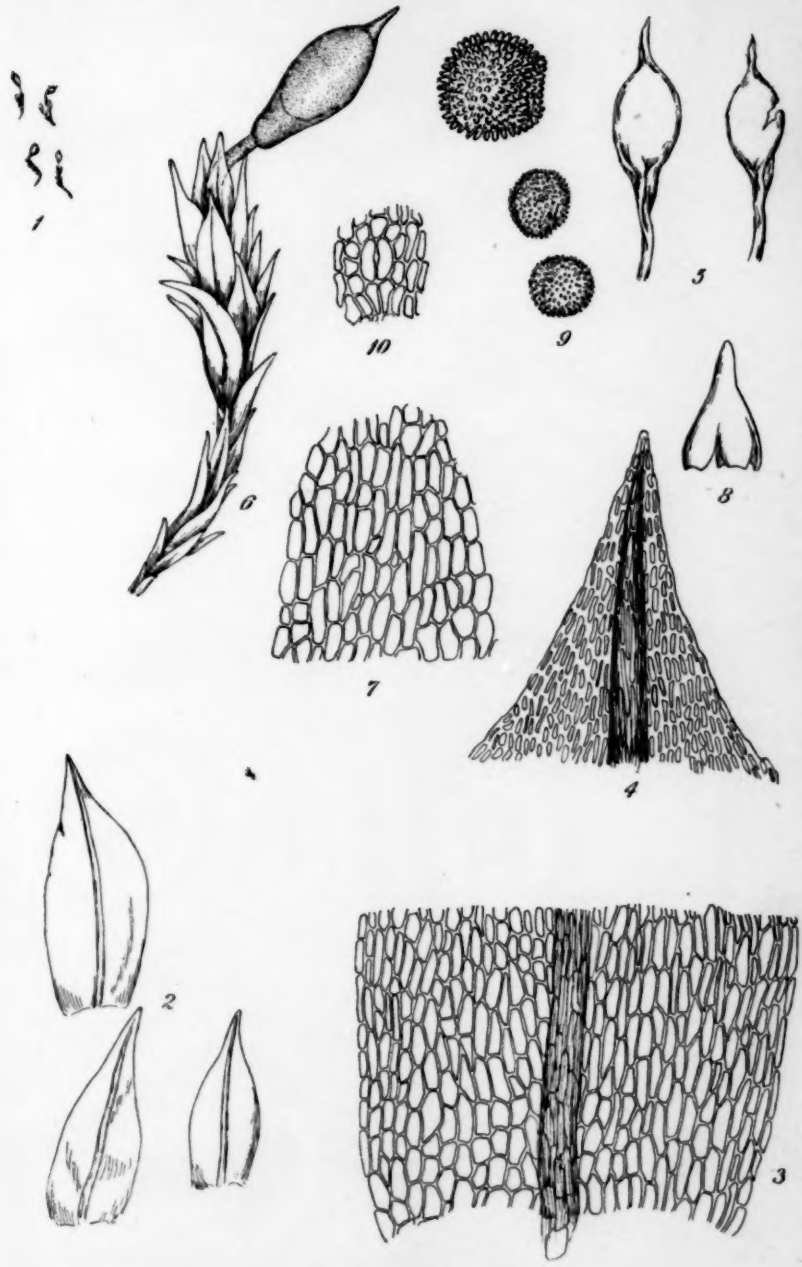

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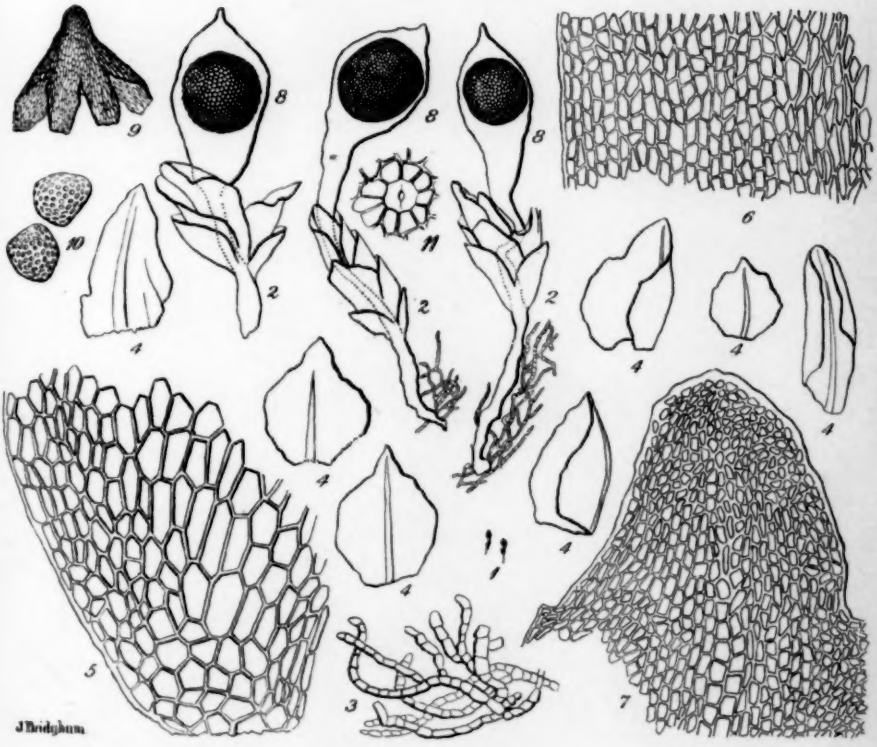

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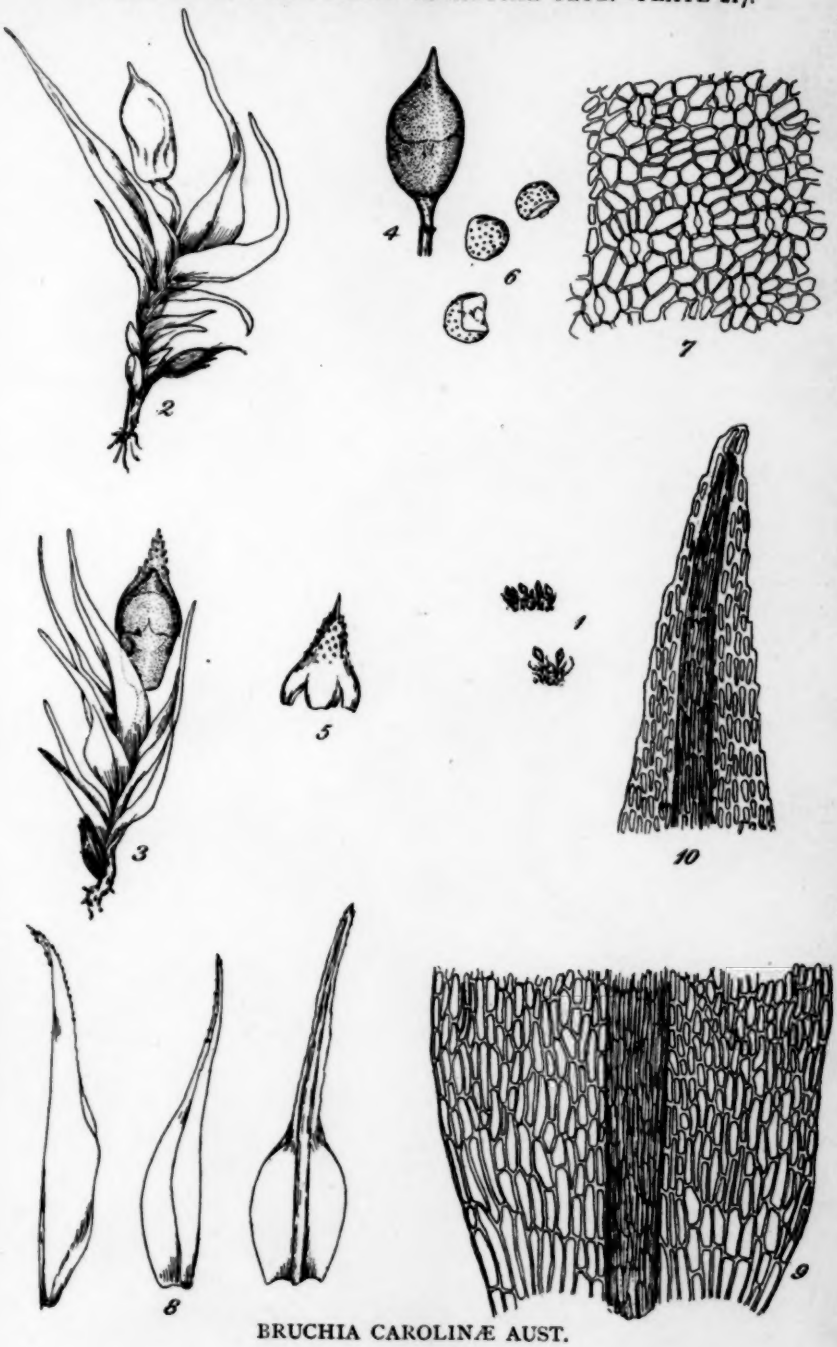

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